AMERICAN MACHINIST

JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

VOL. 13, No. 16. WEEKLY. | NEW YORK, THURSDAY, APRIL 17, 1890. | $2.50 per Annum. SINGLE COPIES 5 CENTS.

COPYRIGHT 1890, BY AMERICAN MACHINIST PUBLISHING COMPANY. For Sale Everywhere by Newsdealers. ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Independent Condensers for Marine Engines.

It has long been recognized by marine engineers that the practice of attaching the air and other pumps necessary to the running of a steamship, to the main engine, was open to serious objections, and of late years the tendency has been toward the use of separate and independent pumps for the condensers, for feeding the boilers, freeing the ship of bilge water, etc. The advantage of this arrangement is that each pump may be run at just the necessary speed for the particular purpose for which it is designed, while at the same time the main engine is stripped of a complicated set of rock shafts, pipes and other connections, the failure of any one of which would seriously impair its action, and might compel its being shut down entirely.

The builders of the large steamers now coming into general use on our Great Lakes are very generally adopting the practice of using triple-expansion engines, together with a form of boiler suitable for the pressure of steam necessary to produce the most economical results, and while it is a fact that the impurity of the water there does not necessitate the use of surface condensers and their attached air and circulating pumps, as at sea, it is being recognized by the best designers and users of marine engines on the Lakes, that still further improvement may be made by stripping the engines of all complications not absolutely necessary for simply turning the propeller shaft.

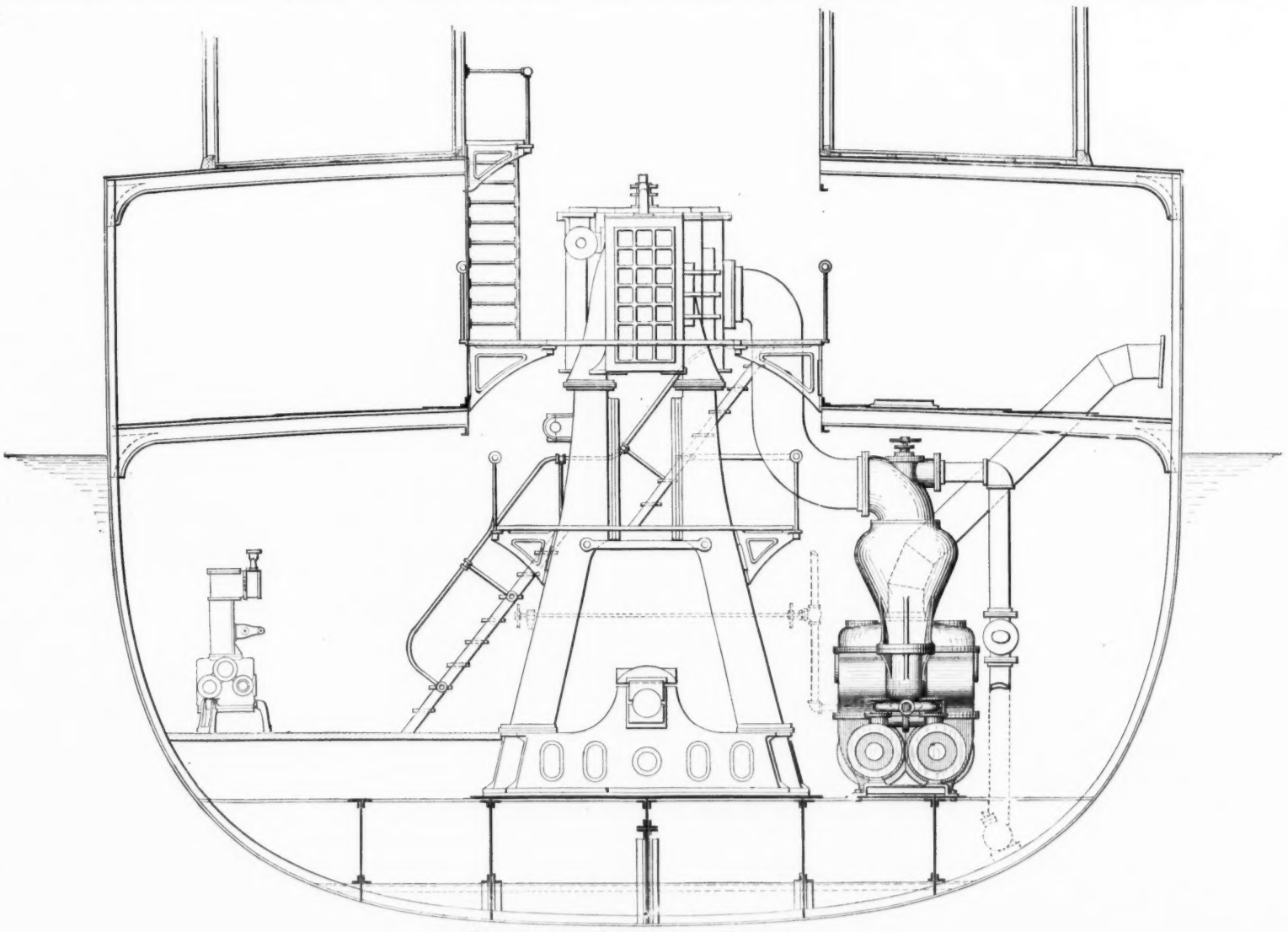
No one so well knows as does the lake engineer the trouble and anxiety attending the use of large air pumps attached to and worked by the main engines, when, as the engine races in a sea-way, the air pump valves are liable to be torn from their fastening, or when, while working in or out of port, a condenser and air pump are liable to become flooded by reason of leaky injection valves, at which times, by a sudden starting up of the main engines, it is quite common to burst the air pump cover or do other serious damage.

One consideration which has led to the use of independent air pumps and condensers on the marine engines of the Lakes is that by their use a constant vacuum is maintained at all times, whether the main engine is at work or standing still.

Another feature of importance has shown itself in this connection, and that is in the matter of the racing of the engine in rough weather. As the independent condenser maintains a constant speed, any increase in the amount of steam exhausted from the main engine when it is racing causes a fall in the degree of vacuum produced, the increased back pressure thus produced having the effect of reducing the power of the engine very considerably, with the result that very soon a speed is reached that cannot be exceeded, thus operating as a check on the engine at a time when such a check is very desirable.

When the air pump is connected to the main engine, of course no vacuum can be obtained until the engine moves, and it often happens that it is not obtained until after the main engine has made several revolutions, which revolutions will be at a slow speed until after the vacuum has been obtained. There is no place where it is more imperative that a marine engine shall be able to start at full power instantly, than in entering and leaving the harbors on the Lakes. The spaces between the piers there are so limited, the harbors and river so crooked, and so filled with craft of various kinds, that not only a mistaking of bells, but a failure of the engine to respond to them promptly, and with full power, often results in a damage to docks, bridges and hulls, amounting to thousands of dollars. Much of this risk is done away with by having an independent condenser that shall at all times maintain a vacuum in the exhaust pipe of the low-pressure cylinder, so that the full power of the engine may be immediately available.

Worthington Independent Condensers have proved entirely satisfactory in this service. The duplex valve motion, which is their characteristic feature, gives the pumps steady and quiet action, and renders practical the use of independent air pumps of large size.



WORTHINGTON INDEPENDENT CONDENSER.

The accompanying illustrations on this and the following page, show it as placed in the new steel propellers "Saranac" and "Tuscarora." These boats are among the largest on the Lakes. Both their hulls and engines were built by the Globe Iron Works Co., of Cleveland, Ohio, for the Lehigh Valley Transportation Company.

Each boat has a tonnage of 3,000, a length of 308 feet, a width of beam of 40 feet, and a depth of hold of 27 feet. The engines are triple expansion, and have a 24″ high pressure, 38″ intermediate, and 61″ low-pressure cylinder, all of 42″ stroke. The steam carried is 160 pounds, cut off at about half the stroke in the first cylinder, making 85 revolutions per minute, the indicated horse-power being 2,000.

The propeller "George C. Hollister" is also to be furnished with a Worthington Independent Condenser. This boat is to be the largest on the Lakes, and is of 3,200 tons burden. The cylinders of this engine are 23″ high pressure, 37″ intermediate, and 62″ low pressure, all with a stroke of 42″.

Other well-known builders are considering the question of replacing the old-style air pump, with its combination of links, levers, rock shafts, bell cranks, etc., by the simple and more reliable independent condenser, and it is quite probable that the Lake steamers of the future will all be furnished with independent condenser, independent feed pumps for the boilers, as well as independ-

ent pumps for fire purposes and for freeing the hull of bilge water.

This type of condensing apparatus, embodying the duplex principle, is built exclusively by Henry R. Worthington, of New York, and is secured by Letters Patent here and abroad.

Mills and Mill Engineering.*

The word "mill," originally designating a machine for crushing or pulverizing food materials and other substances, was afterward taken to include also the containing building with the motor apparatus and all the other appurtenances—to be, in fact, a short synonym for *milling establishment*. The fundamental distinguishing characteristic of such an establishment was that in it useful work was done by mechanisms actuated by power from without. Then the public—with its usual ignorance and disregard of etymological propriety—took the word *mill* as a designation for such establishments in general, even those for making textile fabrics, where the object was not to pulverize materials, but, on the contrary, to arrange them in certain orderly ways with the least possible injury to the fibers.

The word *factory* is a better one etymologically, but it is longer and less thoroughly assimilated from Latin. Its present employment, in connection with certain industries, seems to be a matter of usage or euphony rather than of any strong reason; and the same may be said of the word *shop*.

Thus usage has selected the word mill as a generic term with specific prefixes; and as new industries have developed from time to time, new prefixes have grown on to it—without any order or system—indicating the scope of the business, the source of power, the product made, the process performed, or the material worked.

This movement was not confined to the English language only—substantially parallel ones occurred to a greater or less extent in the other principal languages.

Scientifically considered, this makes a bad jumble; but practically it involves little or no ambiguity. The prefixes tell the story fully and accurately enough, and their meanings are easily learned.

The evolution of the modern system of manufacturing on a large scale and on business principles is the work of this last century of progress. Approximately, 50 years were spent in the immediate preparations for it, and 50 more in its development. This system is one of the three great facts in the present industrial era, the other two being science and steam transportation by water and rail. All before this is the wilderness of hand work, into which Ruskin and Tolstoi and other well-meaning but deluded men imagine they wish to force us back by their talk.

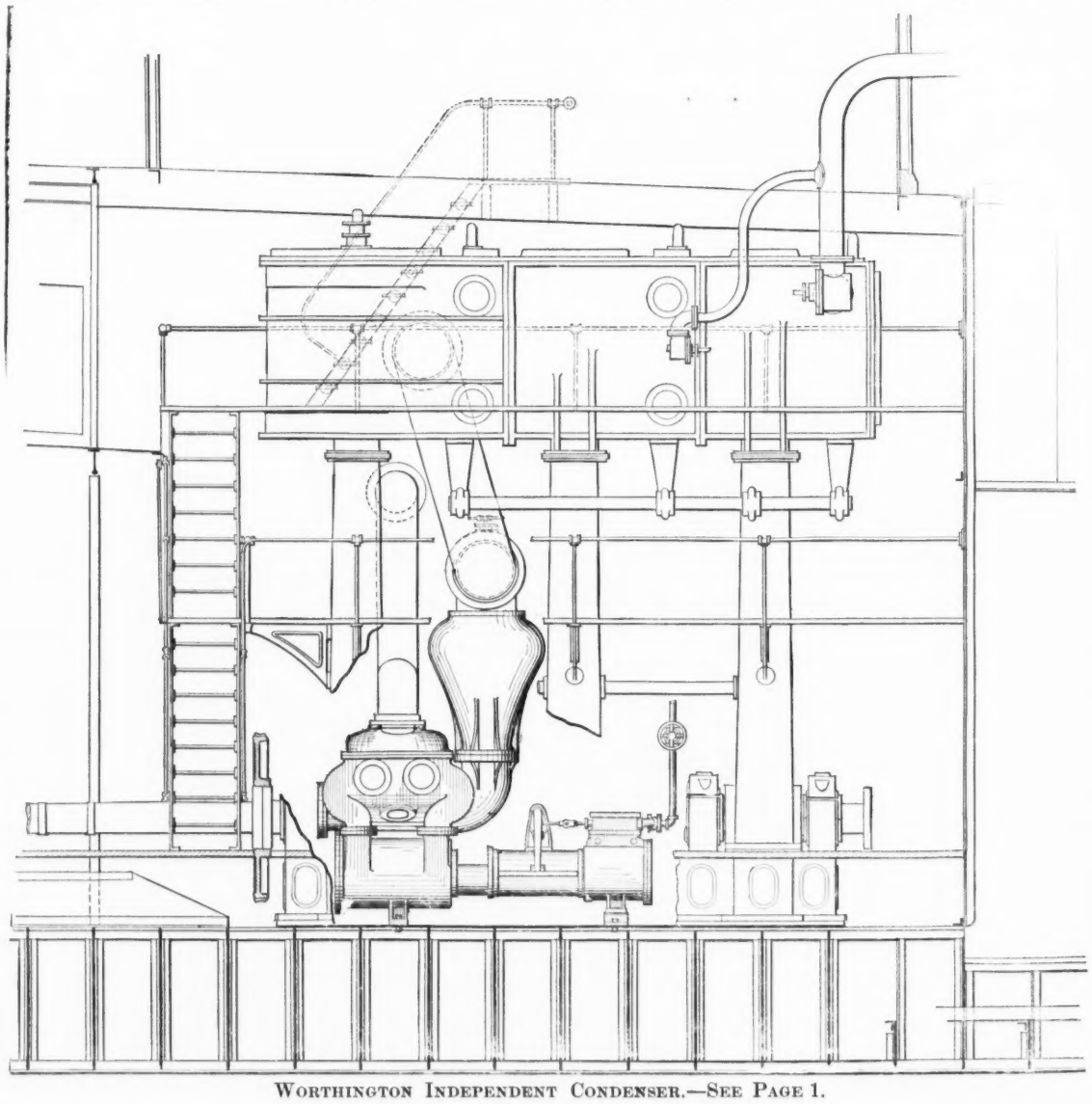
In those old, hard times, the difficulty of transportation compelled each town to be almost a complete industrial system by itself; to do a little of almost everything in the way of supplying its own wants.

If we had time, it would be interesting to trace some of the principal facts and causes in the history of the growth of the mill system and its relations, both of cause and effect, with science and steam transportation; to follow the transition from the era of muscle-power and hand-work to the era of mechanical motors and machinery; which, though now well established, is still in its first youth; but, at the utmost, we can take only time to mention some of the more prominent factors in the case.

Among these must be reckoned, as a *sine qua non*, a full supply of irons at moderate prices. This want began to be met tolerably well by the introduction of mineral fuel in 1745, and of rolling mills and puddling furnaces in 1783 and 1784.

A better supply of power was equally needful—muscle is wholly incompetent to do the world's work satisfactorily. Wind-wheels and water-wheels could and did do much, but only a small fraction of what was needed for a high state of civilization, especially in the absence of steam transportation to carry supplies, materials and products to and from the places where water-power could be obtained.

The improvement of the stationary steam engine into a practical working machine made a long step toward revolutionizing the conditions, allowing power to be furnished and mills to be located at the dictate of general considerations of supply and demand.



WORTHINGTON INDEPENDENT CONDENSER.—SEE PAGE 1.

Machinery was also imperatively required. To have a good supply of this, at moderate prices, machine tools must be had for making it. These tools, various, convenient and effective as they now are, consist mainly or largely of outgrowths and applications of the principle of the slide rest. Even in those machines which involve other features of immense value, like the steam hammer, the modern grinding machine, etc., the principle of the slide rest is an indispensable part of the combination.

Simple and obvious as this device appears, it is one of the most important factors in modern industrial progress. If any one wishes to get a just idea of the radical difference between the old and new ways, and the sharpness of the transition, let him reflect upon the fact that the slide rest was not known by machinists generally till 1794, and was re-invented in that year and put to practical work in connection with the turning lathe; and, further, that, notwithstanding its immense efficiency as a labor-saver and talk excitant, it was not utilized in the building of a metal planer, even for flat surfaces, till 1825. It is stated that the introduction of such machines immediately reduced the cost of producing plane surfaces to less than one per cent. of the cost of equal work by chipping and filing.

In the meantime, many fairly efficient machines had been devised and brought into use in the textile and other industries, so that the mill system of manufacturing was then fairly started.

But the more it grew the more urgent became the need of better means of transportation. The problem of steam transportation by water proved comparatively easy. But it was much less easy to hit upon the proper combinations for success on land, viz., the abandonment of common road surfaces and the substitution of metallic rails, very radical reductions of the limits of gradients and curvatures, the use of high-pressure steam, multi-tubular boilers, and the exhaust blast.

This combination having been completed in 1829, the great essentials for the development of the mill system were ready, viz, the steam engine in good working efficiency, a fairly good supply of irons, machine tools and general machine making, and steam transportation, all well started.

I understand that a gentleman for whom we all have a high respect, in a recent address to an assemblage of Boston merchants claimed that these great movements were caused by the development of the banking system. But long before this was said a parable was invented to answer it, viz., the story of the two Yankees who were thrown upon an uninhabited island in a condition closely approaching to destitution, but in a few days each became rich by trading jack knives back and forth with the other. This champion lie has a poetical thoroughness and vividness which the other statement lacks, but both involve substantially the same absurdity. Many things were indispensable in these improvements without being in any fair sense the cause of them—paper, for instance.

The development of the mill system has been a powerful stimulant to the improvement of water-wheels, or, perhaps, we may say that the latter has been a part of the former.

In the infancy of this country, when there was a superabundance of land, and great reverence for the authority of the State, it was easy for the Government to exercise the right of eminent domain. Later on, the "fierce Democracie," forgetting that their titles originally issued from the State, subject to this right, in all its breadth, contested its exercise for any purpose excepting the laying out of highways. But in the time of Queen Anne it was easy to see the justice and wisdom of using it in aid of mill building to the extent of authorizing any riparian owner to build a dam on his own land, and maintain a head of water for actuating a mill—though it might incidentally flow back over land of owners above—on payment of proper damages, ascertainable by legal proceedings. Neither natural right nor the public interest can be pleaded in favor of allowing an owner of farming lands to also hold waterfalls running to waste through them, when other persons wish to put them to useful work for the general benefit.

In this early time the practical necessity for such aid to mill building was much greater than it is now. The steam engine was not in sight in the future. In Massachusetts the main bulk of the population was spread out to an average of perhaps not more than twenty persons to a square mile, so that the number of people within reach of any mill—by the bad roads then in existence—was not sufficient to promise it much business, and capitalists with a few hundred dollars to invest in building and operating mills were not numerous.

Considering the urgent need for grist-mills and saw-mills, and the unquestioned right of eminent domain, the Legislature of the Province of Massachusetts, early in the eighteenth century, made a law—commonly called the mill act—authorizing flowage under the conditions above stated.

Through all the changes of our statutes this provision has ever since been, and now is, a part of the law of Massachusetts, and it has also long been a part of the law of many other States.

But the right was not restricted to grist-mills and saw mills. In the course of time other industries, in iron, paper, gunpowder, wool, cotton, etc., started and began to use water-power also, in a small way, here as well as in other civilized countries. Establishments for these industries were also styled mills, *i. e.*, assemblages of inanimate machinery and motors for performing certain mechanical operations; and, so far as I know, the point has never been raised against any such establishment that it was not a *mill* within the meaning of the mill act, and no attempt has ever been made to exclude any of them when the general statutes have been revised from time to time.

Thus a cotton mill, a watch factory, a machine shop, or an electric light plant, can, without question, exercise the flowage right originally granted in aid of the grinding of food materials. Rightly, and wisely so, in my opinion. The cases in which injuries by flowage cannot be or are not entirely compensated for by money damages are very rare. Doubtless there are many general laws which involve much greater individual hardship than this. Moreover, the broad and statesmanlike view seems to be that these later industries are as needful to the strength and prosperity of a great country as the little rude grain-mills and saw-mills were to the immediate wants of a poor agricultural one.

In the development of the mill system in

*Extract from a paper read by Mr. Edward Sawyer, before the Boston Society of Civil Engineers, Sept. 18, 1889.

Great Britain, with no considerable water-powers and with a good supply of coal, steam was the only source of power to be considered. In New England the conditions were reversed.

The little beginnings of the bituminous coal business in Maryland were merely local, and not suspected of having any relation to affairs in New England. Anthracite, as a practically useful fuel, was unknown. Here there were many excellent water-powers running to waste near tide-water. Probably no one thought to ask whether there was any other source of power practically available, and, if the question had been raised, every one would have said, without hesitation, that steam power was wholly out of the question, by reason of its much greater cost. Whether the existence of these water-powers suggested the building of mills on a large scale, or the desire to build such mills called attention to the water-powers, it is evident that without the latter the mill system would not have grown up here when it did.

It is easy to see why Lowell should have been selected as the place for manufacturing on a large scale by the Boston promoters, after the success of their first start at Waltham. For the first few years the water-power easily available at Lowell was in excess of the demand. But most of the people seeking for mill sites naturally went there in preference to making large expenditures for land, dams, canals, grading, and other matters needful for developing water-power in other locations.

Thus it happened that the sagacious men who controlled the business in Lowell learned, by the most certain test of experience, that their water-power was very valuable, and looking ahead, they clearly saw that the demand would soon exceed the supply. The conditions were favorable for the development of the genius which would produce a more efficient and convenient water-wheel. The man was already there in the person of Uriah A. Boyden, then or recently engaged in the engineering works of the proprietors of the water-power.

The high-breast wheels used there prior to 1840 were as good as any, and much better than most of the wheels in general use. A few turbines had been made in France and in this country which gave a maximum utilization of 76 per cent. of the water-power expended. The best breast wheels of ample size for the water applied could do about as well, but in practical work they probably gave not more than 55 to 67 per cent., depending largely upon how much water was crowded onto them.

Boyden began soon after 1840 about where Fourneyron left off, and soon ran the utilization up to about 88 per cent. Becoming intensely interested in this work, he continued perfecting the theory, with the aid of careful tests of about 20 turbines of his construction, under falls varying from 7 to 35 feet, until he obtained a utilization of about 95 per cent. His tests were, of course, made with weir measures of the water used and friction brake dynamometer determinations of the power yielded.

Subsequent observations of a less exact nature tend to corroborate this result. The careful experiments of Boyden and others enable us to estimate from the dimensions of a turbine of this type how much water it will use under given conditions, with a close approach to exactness. And good estimates of the power obtained can often be made by alternating the turbine with a steam engine in actuating the same machinery, measuring the whole power and also that absorbed in the engine itself, by indicator cards, and subtracting the latter from the former. In a comparison of this kind which I recently made for a turbine of about 740 horse-powers under 40 feet fall, it seemed most probable that fully 95 per cent. was utilized.

Since 1850 many ingenious men have spent much time and thought for improving turbines in other directions. One desideratum has been cheapness of first cost. Many buyers give too much weight to this. In general it involves putting a large quantity of water through a wheel of relatively small diameter, with more or less lowering of the ratio of utilization. But in many places where water is constantly running to waste, and likely to do so for many years to come, common sense calls for cheap but durable turbines without much regard to economy of water.

Another and more important desideratum has been to make turbines which will give high ratios of utilizations with the gates partly closed. The most favored way of securing this result is by the use of wheels combining inward and downward discharge. This requires a complicated form of bucket, and the theory of the motions and pressures of the water is too abstruse for anything like complete mathematical analysis. Nevertheless, intuitive judgment and patient experimenting have produced several good wheels of this type, whose ratios of useful effect fall off but slowly with diminution of gate opening.

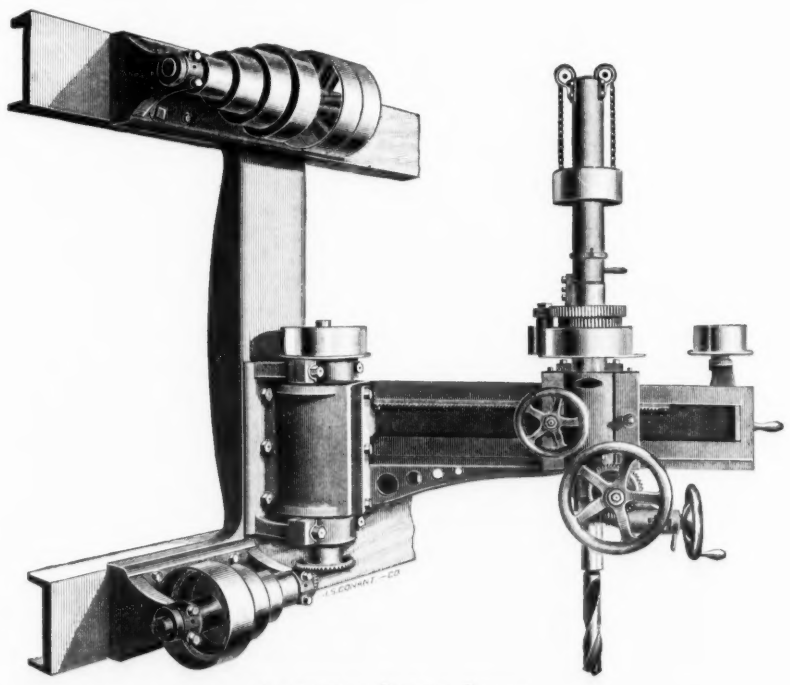
So far as I know, very little improvement in hydraulic motors has originated in Europe during the last fifty years—nothing worthy to be mentioned even, in comparison with what has been done here. Our progress in other branches of hydraulics also compares favorably with all that has been made elsewhere in the same time, notwithstanding the fact that foreign investigators have had large amounts of public money for making extensive experiments.

A few years ago, A. De la Candolle elaborated, at great length, the theory that the best test for gauging the intellects of the different nations is to ascertain how many individuals per million of them have been members of the different learned societies in Europe.

The inadequacy and injustice of this theory, *as applied to the people of this country*, is strikingly apparent when we consider how much more progress we have made in the last sixty years in the theory and practice of hydraulics than all the rest of mankind. Yet our principal workers in this line have gained few if any elections to membership in foreign learned societies. In this gauging of intellects it must be remembered that America is, to a large extent, a world by itself; not been members of any foreign society; they have not run to Europe for recognition. The learned De la Candolle is probably almost wholly ignorant of their existence and their works.

While the improvements in hydraulic motors developed by or with the mill system of manufacturing, since the time of Fourneyron, have been substantially limited to this country, our contributions to progress in steam engineering, automatic tools, electrical work and various other matters, will compare favorably with those of all the rest of the world, and have attracted much more attention than our hydraulic work, they have that our workers are tolerably well content with the substance of progress and acquirement, and have not much time or inclination to struggle for European appreciation; if it comes it is a pleasant incident merely, but it cannot make our discoveries and improvements any more certain—ignorance of them cannot make them a particle less certain.

Babbitt Melting Furnace.



Suspended Radial Drill.

The question of rapid transit in New York city is likely yet to be a vexed one on account of conflicting interests. And it is not an easy question to settle. It is even better to wait a little and digest the plans offered than to get some system that is unsatisfactory.

Furnace for Melting Babbitt Metal.

We give herewith an illustration of a furnace specially designed for the use of machinists who have babbitting to do. It is made by the American Gas Furnace Co., of 80 Nassau street, New York City, and its principle of operation is the same as that of the other furnaces of their construction which we have recently illustrated.

The lining of this furnace is shaped at the top, so as to hold securely the ladle in which the babbitt is placed, while under and about the ladle is what may be termed a cyclone of blue flame, produced by the combustion of a mixture of air and gas supplied under pressure, the gas being taken up by the air by induction, just before entering the distributing ring (which surrounds the fire chamber), and from which it issues, in tangential jets, giving a rapid rotary motion to the flame. The proportion of the air and gas is under control by means of suitable stop-cocks, and the heat may also be regulated perfectly, and will remain indefinitely at any desired point. There can of course be no doubt but that better results can be obtained in the use of babbitt metal by such a furnace in which the heat is perfectly even and controllable, so that it can be kept at the degree best suited to the work. This also, of course, conduces to economy by lessening the waste of babbitt metal by oxidation due to overheating, and there is less spilling of the metal and loss in that way than is apt to be the case where a common forge is used. In some machine shops we know of they have proven far more satisfactory than the usual crude methods employed for this work.

Suspended Radial Drill.

With this we give an illustration of a suspended radial drill press, which is adapted to be attached to beams overhead in such a way as to leave the entire floor space clear for handling and placing work. The arm is 48″ long, and swivels the same as the ordinary radial drill. The method of driving is clearly shown in the cut, the back gears being placed about the spindle so that comparatively high belt speed is obtained. The saddle is moved along the arm by a rack and pinion, the hand-wheel being conveniently located on the saddle. The spindle is balanced by means of the heavy collar attached by chains above as shown, and the feed is by means of worm and wheel. There is a clamp on the saddle by which it can be held firmly in any desired position, and the rack and pinion gears can readily be thrown out of gear, and the head moved in or out to position quickly.

Spindle is of steel $1\frac{3}{8}$″ in diameter, 12″ traverse, with quick return. It is made to fit the No. 4 Morse taper shank. All shafts, studs, etc., are made of steel, as are also the rack and pinion, and gears on feed. Ratio of back gears 5 to 1. The machine shown has no automatic feed, but they are so built when desired, and they may be made with arm to raise and lower, and with a table which can be adjusted to any angle. The builders are C. H. Baush & Sons, Holyoke, Mass.

It is believed in some quarters that quite soon, brine cooled below the cooling point of water will be carried under the streets in pipes, and dealt out to consumers, and that this will be substituted for ice for domestic purposes. It is argued that by this means water purified by boiling could be frozen at home, doing away with the use of impure ice, and a danger of disease.

Mr. William Kent, well known to our readers, has opened an office at 125 Times Building, New York. Mr. Kent will attend to any matters in engineering that may come to him, and, through connection with the Pittsburgh Testing Laboratory, will give attention to the inspection of iron and steel for all structural purposes.

Odontics, or the Theory and Practice of the Teeth of Gears.

By Geo. B Grant.

FIRST PAPER.

5.—KINEMATICS.

This, the science of pure mechanism, relates exclusively to the constrained and geometrical motions of mechanism, and it has nothing to do with the questions of force, weight, velocity, temperature, elasticity, etc. The path of a cannon ball is not within the field of kinematics, because it depends upon time and force. A belt and pulley are kinematic agents, because the contact between them can be assumed to be definite, and the action is therefore geometric, but the slipping and stretching of the belt is not kinematic. The action of gear teeth upon each other is purely kinematic, but we cannot consider whether the material is wood, or steel, or wax, whether the gears are lifting one pound or a ton, or whether they are running at one revolution per second or one per day.

6.—ODONTICS.

The name "odontics" may be selected for that limited but important branch of kinematics that is concerned with the transmission of continuous motion from one body to another by means of projecting teeth.

Even this restricted corner of the whole subject is too large for the present purpose, for it covers much that cannot be considered within our set limits, and gear wheels must, therefore, be defined as devices for transmitting continuous motion from one fixed axis to another by means of engaging teeth.

Thus confined, gear wheels may be conveniently divided into three general classes.

Skew bevel gears, transmitting motion between axes not in the same plane.

Bevel gears, transmitting motion between intersecting axes.

Spur gears, transmitting motion between parallel shafts.

The last two classes are particular cases of the first; for, if the shafts may be askew at any distance, that distance may be zero, and if they intersect at any point, that point may be at infinity.

It would be scientifically more correct to first develop the skew bevel gear, and from that proceed to the bevel and spur gear, but practical clearness and convenience is often more to be admired than strict accuracy, and, as the true path is difficult to follow, we shall enter in the rear, and consider the spur gear first.

Odontics does not properly include the consideration of questions of strength, power and friction, but we must admit certain important items in that direction.

7.—PITCH SURFACES.

The fixed axes are connected with each other by imaginary surfaces called "axoids," or pitch surfaces, touching each other along a single straight line. We must imagine that the pitch surfaces roll on each other without slipping, as if adhering by friction.

The whole object of odontics is to provide these imaginary surfaces with teeth, by which they can take advantage of the strength of their material and transmit power that is as definite as the geometric motion.

The pitch surface of the skew bevel gear is the hyperboloid of revolution, which becomes a cone when the axes intersect, and a cylinder when the axes are parallel.

8.—NORMAL SURFACES.

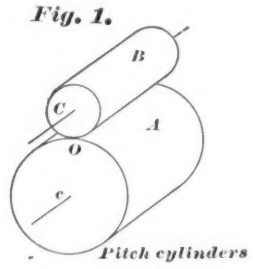
An important adjunct of the pitch surface is the normal surface, or surface that is everywhere at right angles to both pitch surfaces of a pair of axes, and upon which the action of the teeth on each other may best be studied.

For the skew bevel gear there does not appear to be any normal surface. For the bevel gear the normal surface is a sphere, and for the spur gear the sphere becomes a plane.

9.—UNCERTAINTIES.

The theory of tooth action is not yet full and definite in all its parts, for there are some disputed points, and some confusion and clashing of rules and systems. This is particularly the case with the theory of spiral and skew bevel teeth, for much of the work that has been done is clearly wrong, and there is little that has been definitely decided.

Fig. 1.



Pitch cylinders

10.—PITCH CYLINDERS.

Two cylinders, *A* and *B*, Fig. 1, that will roll on each other, will transmit rotary motion from one of the fixed parallel axes *c* and *C* to the other, if their surfaces are provided with engaging projections.

When these projections are so small that they are imperceptible, the motion is said to be transmitted by friction, and it is practically uniform. But when they are of large size, and readily observed, the motion, although it is unchanged in nature, is said to be transmitted by direct pressure, and it is irregular unless the acting surfaces of the projections are carefully shaped to produce an even motion.

The whole object of odontics is to so shape these large projections or teeth that they shall transmit the same uniform motion between the rotating cylinders, as would be apparently transmitted by friction.

These cylinders are imaginary in actual practice, although they are one of the principal elements of the theory, and they are called the axoids, or pitch cylinders of the gears.

The normal surface (8) of the spur gear is a plane, and, as all sections by normal surfaces are alike, we can study the action on a plane figure easier than in the solid body of the gear.

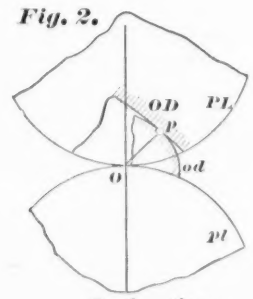
11.—THE LAW OF TOOTH CONTACT.

With the above conditions given we can deduce the following law:

The common normal to the tooth curves must pass through the pitch point.

That is, in Fig. 2, if the tooth curves *O D* and *o d* are to transmit the same motion between the pitch lines *p l* and *P L* as would be transmitted by frictional contact at the pitch point *O*, they must be so shaped that their common normal *O p* at their com-

Fig. 2.



Tooth action

mon point *p* shall pass through that pitch point.

Conversely, if the tooth curves are so shaped that their common normal always passes through the pitch point, they will transmit the required uniform motion.

12.—THE ODONTOID.

This universal law enables us to define the "odontoid," or pure tooth curve, for the contact of the pitch lines at the pitch point is continuous and progressive, and, if the tooth curves are to transmit the same motion, their normals must be arranged in a continuous and progressive manner. The normals *n l*, as in Fig. 3, must be arranged without a break or a crossing, not only springing from the odontoid at consecutive points, but intersecting the pitch line at consecutive points. This arrangement may be called "consecutive," and the definition is not a

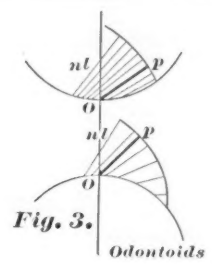


Fig. 3. *Odontoids*

law by itself, but an expression of the given universal law.

It is seen that the odontoid is inseparably connected with its pitch line, and that the same curve may be an odontoid with respect to one pitch line, and not with respect to some other. The curve, Fig. 4, is an

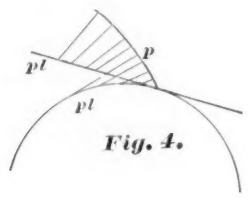
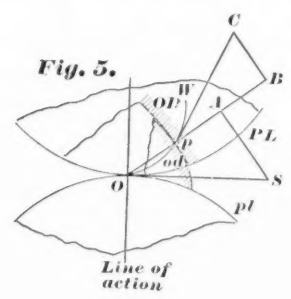


Fig. 4.

odontoid with respect to the pitch line *p l*, but not with respect to the pitch line *p l'* beyond the point *p* at which the normal is tangent to that pitch line.

The odontoid, so far as defined, is not a definite thing, and, for practical purposes, it must be given some particular shape. It may be involute or cycloidal, or of other form, but must always have normals arranged in consecutive order.



13.—THE LINE OF ACTION.

As the tooth curves *o d* and *O D* (Fig. 5) work together, the point of contact will travel along a line *O p W* called the "line of action."

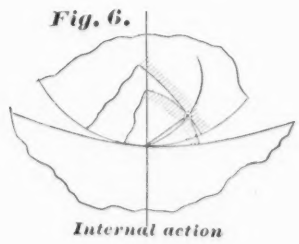
There is a definite relation between the odontoid and the line of action, so that, if either one is given, the other is fixed. If the odontoid *O D* is given, with its pitch line *P L*, the line of action is determined without reference to the pitch line *p l* or its odontoid; and, conversely, if the pitch line and line of action are given, the odontoid to correspond is determined.

14.—INTERCHANGEABLE ODONTOIDS.

This feature leads at once to the broad and useful fact that all odontoids, on pitch lines of all sizes, that are formed from the same line of action, will work together interchangeably, any one working with any other.

Therefore, to produce an interchangeable set of odontoids we can choose any one line of action, and form any desired number of them from it.

Fig. 6.



Internal action

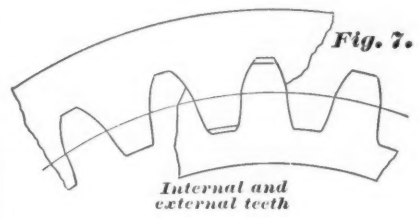
15.—INTERNAL CONTACT.

The pitch lines of Fig. 5 curve in opposite directions, and the contact is said to be "external." But the principles involved are independent of the direction of the pitch lines, and they may curve in the same direction as in Fig. 6, in "internal" contact.

Tooth contact is between lines only, there being no theoretical need of a solid material on either side of the line, so that either side of the tooth may be chosen as the practical working side.

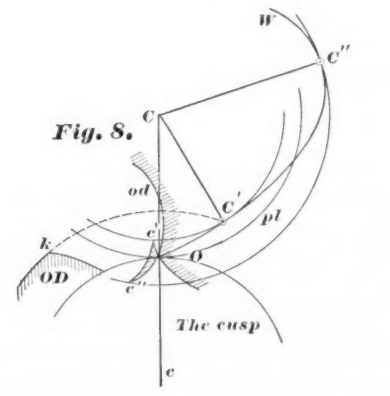
Therefore the internal gear is precisely like the external gear of the same pitch diameter, working on the same lines of action, so far as the odontoids are concerned, as illustrated by Fig. 7.

Fig. 7.



Internal and external teeth

Fig. 8.



16.—THE CUSP AND INTERFERENCE.

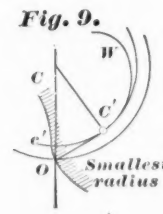
When, as in Fig. 8, the pitch circle *p l* is so small with respect to the line of action *O C' C'' W*, that two tangent circles *C' c'* and *C'' c''* can be drawn to the line of action from the center *C* of the pitch line, we shall have a troublesome convolution in the resulting flank curve *o d*. This convolution will be formed of two cusps, a first cusp *c'* on the inner tangent arc, the "base circle" *C' c'*, and a second cusp *c''* on the outer tangent arc *C'' c''*.

This happens with any form of odontoid, although sometimes in disguised form, and creates a practical difficulty that can be avoided only by stopping the tooth curve at the first cusp *c'*.

Furthermore, any odontoid *O D* that is to work with the odontoid *o d*, must be cut off at the point *k* on the "limit line" *C' k* through the point *C'* from the center *c*.

If the odontoids, when the pitch line is so small that the cusps occur, are not cut off as required, the action will still be mathematically perfect, but as the contact changes at a cusp, from one side of the curve to the other, the action is no longer practicable with solid teeth, for the curves will cross each other, and there will be an interference.

Fig. 9.



17.—THE SMALLEST PITCH CIRCLE.

To determine the smallest pitch circle that can be used, and avoid the cusps altogether, find by trial the point *C*, Fig. 9, from which but one tangent arc *C' c'* can be drawn to the line of action *O C' W*. This point will be the center of the smallest pitch circle, and all points outside of it will avoid interference, while all inside of it will be subject to it.

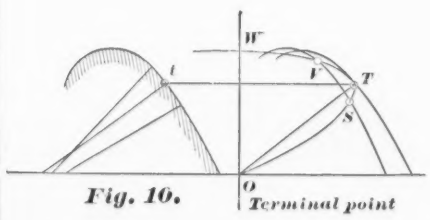


Fig. 10.

18.—THE TERMINAL POINT.

When a tangent arc can be drawn, from the pitch point *O* as a center, to the line of action at any point *T*, except the vertex *W*,

Fig. 10, there will be a corresponding crossing of the normals to the odontoid commencing at the point t, and a termination of the action when the point t reaches the point T.

As the action approaches the terminal point T there will be two points of action, since the odontoid crosses the line of action at two points—one point of direct and ordinary action at S, and another point of retrograde and unusual action at V. These two points of action will come together at T, the odontoid will leave the line of action, and all tooth action will then cease.

The retrograde action is theoretically and actually correct, but it is so oblique that it is of no practical value, and therefore the odontoid may as well be cut off at its terminal point t.

19.—SPEED OF THE POINT OF ACTION.

Lay off $O\ S$, Fig. 5, to represent the speed of the pitch lines, and draw $S\ A$ at right angles with the common normal $O\ p$. Draw $p\ C$ tangent to the line of action at the point of action p.

Lay off $p\ B$ equal to $O\ A$, and draw $B\ C$ at right angles to $O\ B$. Then $p\ C$ will be the speed of the point of action along the line of action.

When the line of action is a circle the angle $S\ O\ A$ is always equal to the angle $B\ p\ C$, and therefore the speed of the point of action is uniform, and equal to that of the pitch lines.

If the line of action is a straight line the angle $B\ p\ C$ will be constant—always zero—and therefore the speed of the point of action will be uniform and always equal to $O\ A$.

20.—NATURE OF THE TOOTH ACTION.

The nature of the action may be determined by a study of the normal intersections; the intersections of the normals with the odontoid being at uniform distances apart, their intersections with the pitch lines will indicate the action of the teeth. If the normal intersections, as in Fig. 3, are quite regular, the action of the teeth will be smooth and regular, while if they are crowded within a narrow space the action of the tooth will be crowded and jerky.

21.—THE SECONDARY LINE OF ACTION.

From the universal law of tooth contact stated in (11) we can reason that any point on the tooth curve is in position for contact whenever its normal passes through the pitch point O, and therefore that the point will then be upon a line of action.

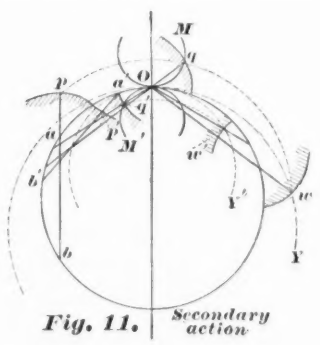


Fig. 11. Secondary action

In Fig. 11 the normal to the point p must cross the pitch line twice—at a primary intersection a, and at a secondary intersection b, and therefore there will be a point of action on a primary line of action $O\ M$ at q, when the curve has moved so that the primary point of intersection a is at the pitch point O, and a point of action w on a secondary line of action, when the secondary point of intersection b has reached the pitch point.

Therefore there will generally be not only the primary line of action $O\ q\ M$ or $O\ q'\ M'$, but also a secondary line $O\ w\ Y$ or $O\ w'\ Y'$.

The secondary line of action must have the same property as the first, as a locus of contact, and therefore if we can so arrange two pitch lines with their odontoids that their secondary lines of action coincide, there will be secondary contact between the odontoids.

When it so happens that both primary and secondary lines coincide, we shall have double contact. Two points of contact will exist at the same time, one on the primary and the other on the secondary line of action.

The secondary lines of action cannot be made to coincide when the contact is external, but when it is internal they sometimes can be, so that the matter has an application to internal gears.

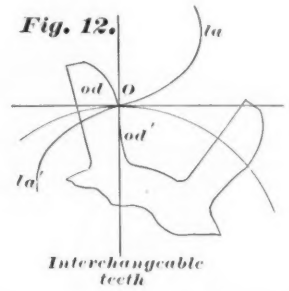
It is to be noticed that the primary line is independent of the pitch line, while the secondary is dependent upon it.

Secondary contact is an interesting feature of tooth action, but it is of small importance, and has been studied but little.

22.—THE INTERCHANGEABLE TOOTH.

The simple odontoid so far studied is the perfect solution of the problem from a mathematical point of view, for it will transmit the required uniform motion as long as it remains in working contact. But from a mechanical point of view it is still incomplete, as it works in but one direction, through but a limited distance, and, although the odontoids are interchangeable, the gears are not.

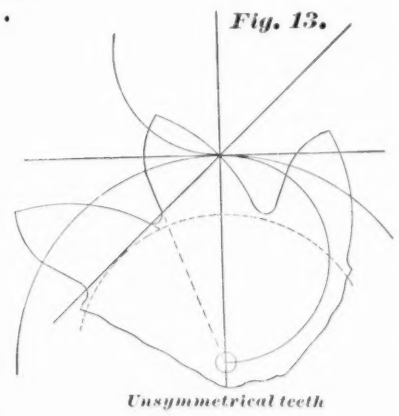
In order that the gears shall be fully interchangeable, it is necessary that the teeth shall have both faces and flanks, and that the line of action for the face shall be equal to that for the flank; that is, the tooth must have an odontoid on each side of the pitch



Interchangeable teeth

line, the face $o\ d$, Fig. 12, outside, and the flank $o\ d'$ inside of it, and the line of action $l\ a$ for the faces must be like the line of action $l\ a'$ for the flanks. If so made, any gear will work with any other, without regard to the diameters of the pitch lines.

But such a gear will run in but one direction, and to make it double-acting it must have odontoids facing both ways, as in Fig. 13. Gears so made will be both double-acting and interchangeable, and it is not necessary that both sides of the tooth shall be alike.



Unsymmetrical teeth

Again, the unsymmetrical gear of Fig. 13 fails when it is turned over, upside down, for then the unlike odontoids come together, and, to avoid this last difficulty, all four of the lines of action must be alike, producing the complete and practically perfect tooth of Fig. 14.

We can therefore define the completely interchangeable tooth, as the tooth that is formed from four like lines of action.

23.—INTERCHANGEABLE RACK TOOTH.

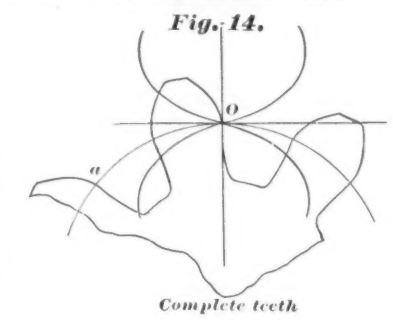
When the pitch line is a circle the flanks of the tooth are not like the faces, but when it is a straight line there is no distinction between face and flank.

We then have the important practical fact that the four odontoids of the interchangeable rack tooth are alike.

24.—CONSTRUCTION BY POINTS.

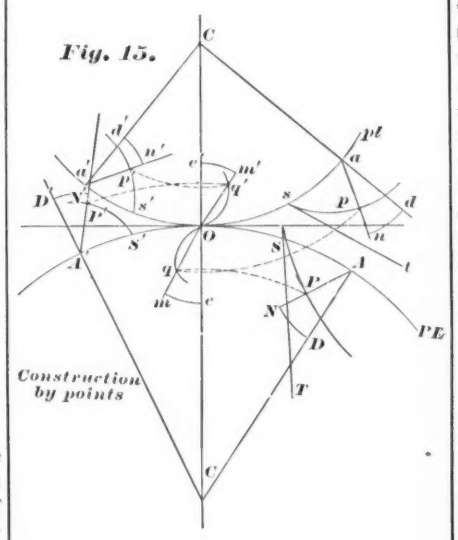
When we have an odontoid and its pitch line given, it is a very simple matter to construct either the line of action or the conjugate odontoid for any other pitch line.

We know, for example, the odontoid $s\ p$, Fig. 15, on the pitch line $p\ l$, and it is required to construct an odontoid on the pitch line $P\ L$ that is conjugate to it.



Complete teeth

As the odontoid is given we know or can construct its normals. Construct the normal $p\ a$ from any chosen point p, draw the radial line $d\ a\ C$, lay off $A\ O$ equal to $a\ O$, draw the radial line $A\ C$, lay off the angle $N\ A\ D$ equal to the angle $n\ a\ d$, lay off $P\ A$ equal to $p\ a$, and P will be a point in the required conjugate odontoid $S\ P$. $P\ A$ will be a normal to the curve. Construct a number of



Construction by points

points by this process, and draw the required curve through them. The tangents $s\ t$ and $S\ T$ make equal angles with the pitch lines, so that the required curve can often be fully determined by drawing its tangent and one or two points.

To construct the line of action, make the angle $m\ O\ e$ equal to the angle $n\ a\ d$, and lay off $O\ q$ equal to $p\ a$. The point q is on a circle from either p or P drawn from the centers C, and is the point at which p and P will coincide when the two curves are in working contact, the normals $p\ a$ and $P\ A$ then coinciding with the radiant $O\ q$.

When the line of action alone is given, the odontoids for given pitch lines are fully determined, but there seems to be no simple graphical method for constructing them except for special cases. They can be obtained

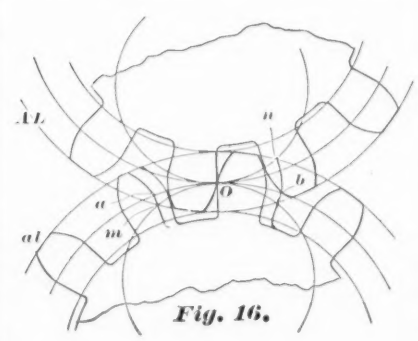


Fig. 16.

by the use of the calculus (33), or drawn by the integrating instrument of (34).

The two tooth curves thus constructed are paired, and are said to be "conjugate" to each other.

25.—THE ARC OF ACTION.

The action between two teeth commences and ends at the intersections m and N of the line of action with the addendum lines of the two gears, $a\ l$ and $A\ L$, Fig. 16. The arc of action is the distance $a\ b$ on the pitch line that is passed over by the tooth while it is in action.

The arc $a\ O$ passed over while the point of contact is approaching the pitch point, is called the arc of approach, and $O\ b$, that passed over while the action is receding from that point, is the arc of recess

With a given line of action the arcs of approach and recess can be controlled by the addenda. If it is desirable to have a great recess and a small approach, the addendum of the gear that acts as a driver is to be increased. When there is a limit line (16), it limits the addendum and the arc of action.

The Modern Steam Plant and its Management.

By Peter H. Bullock.

PISTON PACKINGS AND CROSSHEADS.

In regard to piston packing, and the care of the same, I will admit my unwillingness to give any explicit advice, because there are so many kinds, and each has ills peculiar to itself, that I fear any direct advice that might be given as the proper thing to do under certain circumstances would get mismated, and make trouble where the conditions were different. Having been brought too near the golden stairs by taking some misfit medicine that had been prescribed for and left over by a diseased uncle, whose symptoms were said to have been "just like" my own, I have since felt the importance of the fact that each case should be separately diagnosed before any previously prescribed remedies are applied. With the above precautionary explanation as a warning, the following on the subject of piston packing is submitted.

If the packing is a single ring, the spring is often in one piece, with its ends turned out to fit into holes or notches on the inside of the ring. In cases like this it is often possible to get the proper pressure by putting a strip of thin sheet-iron between the ring and spring, or the inside of the spring may be pened with an oval-faced hammer on a smooth anvil, or, if you know how, the spring may be re-tempered; but don't attempt to get it done at Brown's horse-shoeing emporium, for they are apt to get an interfering temper, or a toe-weight shape onto packing springs.

If there are several small springs, the stiffest ones should be selected for the top, as these have to carry the weight of the section of ring, besides pressing it against the cylinder. If the springs are adjustable by screws, all will depend on the judgment used in operating them. Two things must be remembered: first, that an enormous pressure can be put on the spring and packing by a pretty small wrench, and second, that it is not necessary to institute such pressure. When you have got the proper tension on the springs, do not do anything else until the bolts or studs are held firmly in place by the lock nuts or other means provided therefor, for no matter how fine the adjustments may have been, the work will be quickly lost, if the parts are not secured. I have seen a follower taken off, and every nut, spring and bolt was out of place, and all neatly polished from the indefinite term of tumbling they had received in the piston.

There are several varieties of packing that consist of from two to ten pieces. Where the number is more than two, there is usually a separate spring for each piece, and if they are adjustable ones care should be taken to get an even tension on them all. Although the pieces of packing are originally made interchangeable, they are usually numbered, and it is best to put them back just as they came out, for they will be worn together in places, and these will be less liable to leak than if mismated. When piston packing is properly fitted, adjusted and lubricated, the piston or cylinder will not be cut or grooved if dry steam is used. I am perfectly aware that foreign matter may be brought over from priming or foaming boilers, and work havoc in the cylinder, but I do claim that, having good care and barring accidents, cylinders need not be cut or grooved.

CROSSHEADS.

The crosshead bears the same relation to the outer end of the piston rod as the piston does to the inside end, that is, its office is to guide the rod in a straight line, and it is important that this line should not only be straight, but that it should be perfect with

the cylinder center. The causes that tend to get a crosshead out of line are far more numerous than in the case of the piston. It is exposed to constant thrusts from the angularity of the connecting rod, to the wear incident to the weight it has to carry on guides that are favorably located for the collection of dust, and to the attacks of persons who seem to think that every noise they hear comes from a loose gib, and at once proceed to "adjust" the most accessible screws, which are often the ones that would not need to be touched, even if any did. If the crosshead is out of line, it will give the same movement to the gland as when the piston is not properly centered, and will result in the same cutting of the rod and leakage of steam at the return stroke. If the crank-shaft is at right angles to the center line of the engine, there will be nothing to induce wear in any other direction, except up or down (if the engine is horizontal), according to which way the crank turns. It is a peculiar fact that a crosshead may gradually get out of line, wearing all parts together, and finally get into a condition where you will have to let it remain so, or else do a thorough job, by turning up the rod, bushing the gland and re-lining the crosshead. In an outlying part of a plant, a friend of mine took charge of, he found an old engine that had been running in a dusty shop for a good many years, and the wear of the parts had all been taken up in such a manner that the crosshead was $\frac{5}{16}$ths of an inch too low, still the engine was running fairly well. It was lined up, but when started it gave a noisy and heated protest against any partial improvements. Every part had found new, but untrue bearings, and only a thorough shop overhauling made things right. It is like the use of liquor by a man, who may get into such a condition that if he suddenly stops it unbalances him. Don't get into this condition, or let the crosshead get out of line.

In engines of the Corliss type there is usually a narrow level space between the inclined sides of the ways, and on which there is no wear, and from which all measurements should be made when adjusting to get the piston rod central. For making these measurements it is better to use an instrument as shown in Fig. 13, than to depend upon calipers, for this will always stand square and everybody cannot hold calipers so. It is similar in design to the gauge used for centering pistons, only the lower point is replaced by a fish-tail shaped piece, and the sliding point is straight instead of being turned at right angles.

In some styles of engines the guides are made longer than the stroke, so that the gibs do not wear the ends, and correct measurements may be got from such places. In engines of more recent design, the adjustment of the crosshead is made by screw wedges, or the two parts of the gib or shoe form an inclined plane, and are moved by a fine screw, either way being a great improvement over direct-acting studs or set screws.

Fig. 13.

The motion of the connecting rod brasses on the crosshead pin being an oscillating one, the tendency is to wear the pin into an oval shape, but if well lubricated and not keyed up too tightly, they should not become worn to a troublesome extent in many years. Where the pin is an inserted one, it is sometimes possible to give it a quarter turn occasionally, but if cast solid, as is more often the case, and they become too much worn, they will have to be turned up in a lathe attachment provided for this purpose.

No crosshead should ever be without some reliable and adjustable lubricating arrangement for both the guides and the pin. For slow-running engines a thin strip of steel attached to the end of the gib, and carrying a small piece of spongy material, which drops into an oil pocket at the end of the guides, makes a very satisfactory arrangement. But for high-speed engines, glass cups with screw spindles and sight feed are by far the best. These can be procured with adjustable fixtures, and so arranged that two sets of three each will oil both guides and pin, and the main bearing crank-pin and eccentric. As a matter of economy, it pays to have sight-feed oilers, for then it is possible to gauge the amount to just what is needed, which often is but little, but that little must get there about the right time, if we want to keep things moving smoothly.

Forty-eight-Inch Radial Drill.

The accompanying cut represents a recently improved radial drilling machine, put upon the market by the Betts Machine Co., Wilmington, Delaware. Power is received by a cone of four speeds, back geared, giving eight changes to the spindle through suitable shafts and gearing.

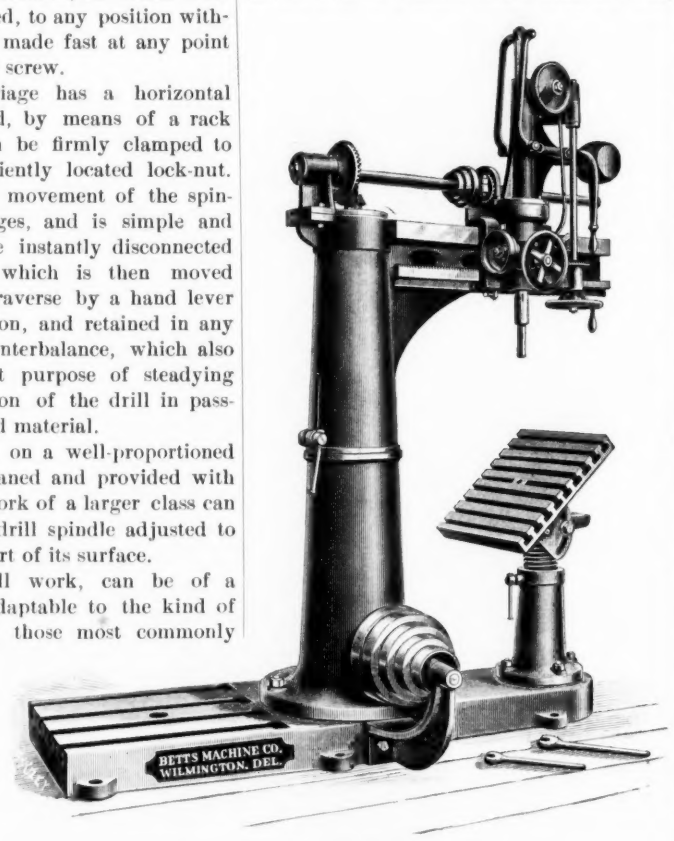
The arm, upon which the saddle moves radially, has a long bearing fitted to the upper part of main column, on which it revolves, when required, to any position within its range, and is made fast at any point by a single clamping screw.

The spindle carriage has a horizontal movement, by hand, by means of a rack and pinion, and can be firmly clamped to the arm by a conveniently located lock-nut.

The vertical feed movement of the spindle has three changes, and is simple and effective; it can be instantly disconnected from the spindle, which is then moved through its entire traverse by a hand lever in convenient location, and retained in any position by the counterbalance, which also serves the important purpose of steadying the downward motion of the drill in passing through unsound material.

The column rests on a well-proportioned base plate, truly planed and provided with T slots, on which work of a larger class can be placed, and the drill spindle adjusted to operate upon any part of its surface.

Tables, for small work, can be of a variety of forms, adaptable to the kind of work to be drilled; those most commonly used are the round, square hinged, and box tables—the two former styles are mounted in a short column, and are raised and lowered either by a screw or rack and pinion, and the latter is mounted on a slide on side of the column, and adjusted by a screw.



Forty-eight Inch Radial Drill.

LETTERS FROM PRACTICAL MEN.

Novel Form of Whetstone.

Editor American Machinist:

At the risk of giving information which is already well known, though I have never seen it either published or widely in use, I purpose describing a form of whetstone, for pattern makers' use, which has not only the merit of cheapness, but of efficiency. The form I am about to describe is perhaps most suitable for the sharpening of trying plane irons, to which it gives a very keen cutting edge, which should, however, receive a final polish off upon a leather strop.

Prepare in the first place a piece of wood,

Whetstone.

mahogany or other good straight timber, of fair hardness, and of the length and breadth of an ordinary oilstone. Next take a piece of sheet zinc, about $1\frac{1}{2}$ inches longer than the wooden slab, and of the same width, and about $\frac{1}{16}$ inch thick, or even less. Flatten the zinc well between two pieces of wood or iron, and lay it upon the slab and clamp tightly on it by means of another equal sized slab. The zinc will then project $\frac{3}{4}$ inch over the ends of the slab, and must be turned down upon the slab ends, and secured by two or three wood screws, as shown in the annexed figure, which represents the end of a whet slab thus constructed. The slab is now to be put into a case, with loose cover, just as an ordinary oil stone.

In using this whet slab, oil is employed in the usual way, but the grinding quality is obtained from the *finest* flour emery, dredged on from a pepper-box, enough oil being used to make a fairly fluid mixture.

Thus employed, a very fine, though quick cutting surface is obtained, giving a remarkably keen edge to a plane or broad chisel, such tools being finished on a leather-faced block, as common with pattern makers, the emery from the grinding slab, which gets carried over to a small extent with the tool, being all that is needed as dressing on the leather.

I cannot say how a slab of cast zinc would do in place of the rolled sheet, but should not think it would be so suitable, and I have known a slab as described to last for two years in regular use, before a new zinc strip was required. The zinc itself does not seem to wear fast at all, but to act as a surface, on which the minute particles of emery obtain a hold sufficient to enable them to act against the steel blades. Very possibly this may be news to many, if not to everyone, and I send it in hopes it may prove useful.

W. H. Booth.

Pumping Water to an Abnormal Height.

Editor American Machinist:

Neighbor Booth's article on lifting water forty feet by suction, and the explanation of how it may have been done, has been rather of a sticker to me. Now I do not want to be a doubting Thomas, and take a trans-Atlantic voyage to see, before I will believe, but I do want a little more corroborative evidence on the subject, as it is so radically opposed to all theory and previous practice. No doubt water can be lifted to most any height by compressed air admitted below, but that it can be lifted forty feet by any suction pump, seems rather doubtful. The writer has for some years pumped the water supply for a very permanent community, from a central cylindrical drum connected to and supplied by numerous driven wells. The vertical lift varies in seasons from 21 to 28 feet, and the pumps are 500 feet away. In order to find the friction in the horizontal pipe, two correct vacuum gauges were placed, one at the pump, and one at the wells. I had found it quite possible to run the pump faster than the 8″ pipe could supply the water, and the pump would pump, a part of the stroke, showing that the cylinder was not wholly filled, but on slowing the speed everything would be right again. Then, to see how it would affect the suction, I removed the gauge at the drum, and let in a little air. The right combination on the air plug theory was missed, for the pump not only jumped, but the suction was lost for some minutes, and the air admitted at the drum appeared at the delivery. I have grave doubts that a larger amount of air would have made the experiment a success.

Owing to a recent experience of my own I suggest a re-measurement of that lift. A line of shafting was required for a room, and my measurement by tape line was 48 feet, and four 12 foot lengths were ordered, but when laid on the floor they were four feet longer than the room. The tape was again applied, and the room was 48 feet and the lengths of shaft were 12 feet each. Moral—don't lend your tape line. On examination, mine had a vacation of four feet between the 17 and the 21 foot station and the joint was one of the most creditable pieces of needlework I ever saw.

Peter H. Bullock.

Pumping Water More Than 34 Feet High.

Editor American Machinist:

In March 20th issue of the American Machinist, Mr. W. H. Booth calls attention to a case where a condenser lifts water 40 feet, and gives as an explanation that the water was charged with some gas. There is no doubt that, in some localities, well water is charged with some carbon or hydrocarbon compounds, such as carbonic acid, marsh gas, etc.; but I hardly think that any well water contains enough of this gas so as to give off an equal volume under a vacuum.

Should there be a plug of gas and of water alternately, the pipe being large enough, and the gas being the lighter of the two, would naturally rise, leaving the plug of water at the bottom end of the pipe; if air should be admitted, as Mr. Booth suggests, it would in most cases impair the working of a condenser, and we know that but a small quantity of air or gas, which would not condense immediately on coming under pressure, would cause a pump to lose its water, on account of the large clearance most pumps have.

I have seen two similar cases, of which I will give the conditions and an explanation that appears most rational to me. I am positive that the water in both cases was not charged with any gas.

In the first case there was a direct-acting pump, about 8″x18″ water cylinder, tapped for a 5″ suction pipe, but only a 4″ pipe was put on; this pipe ran down from the pump 8 feet, then horizontally 60 feet to the well, and then down into the well 29 feet, making a total vertical rise of 37 feet. Usually when the pump was started, the end of the pipe was immersed from 3 to 5 feet, and the pump would keep on pumping until the water dropped below the end of the pipe. If we calculate the body of water in that horizontal section of pipe, and the velocity that the speed at which the pump was run was able to give it, we can see that there is enough work stored in that body of water to raise a column of it considerably above where the pump stood before it would come to a standstill.

In the other instance a double-cylinder fly-wheel pump lifted water through a straight vertical pipe, a little over 34 feet. In both cases there was an air chamber on the suction pipe, and the pumps had to run above a certain speed, or they would lose water. The only explanation that I can see, outside of Mr. Booth's gas theory, which may be correct in certain parts of the country, is that the atmospheric pressure forces water to a certain height; in reaching that point it attains a certain velocity, which in

all cases must be sufficient to force the water the remainder of the distance up to the pump. Geo. J. Mashek.

Another Quarter-turn Belt Substitute.

Editor American Machinist:

Seeing articles in the paper from time to time on belting devices to do away with the quarter-turn belt and the mule pulley stand, also the bevel gearing, which is more or less objectionable, I send you the device shown, which I think is way ahead of what has appeared so far. An explanation is not required, it is so simple. I might say, however, that pulley *A* or *B* can be the driver, and it is also apparent that they need not be in the same plane. Pulleys *C* or *D*, either one or both, can be loose.

The wear on the belts is much reduced.

P. J. Fickinger.

Shop Rules.

Editor American Machinist:

A friend of mine who "once upon a time," as the story books say, started a machine shop, made me his "consulting engineer." My fees—as usual with American consulting engineers—consisting of abuse when his opinion differed from mine, and thanks when we agreed. We agreed on a sufficient number of points, however, so that I think, now that the shop has been completed and put in operation, that it is just about my ideal of a machine shop, so far as arrangement and equipment are concerned.

The last matter about which he consulted me was regarding a set of rules for the shop. He said, "Now, Pandie, you know I have started in to have a first-class shop, and I want to keep it first-class. You know my work is not of the very finest kind, but I want to do it as well as there is any occasion or demand for, and at less cost than any other manufacturer in the country. Now I want to get up a set of rules and regulations which will keep things moving right along and in order; and as you have been around a good deal, and must have seen a good many shop rules, I want your help on this thing." Well, I gave my friend a severe shock by informing him that, in the matter of shop rules, I was what might be called a philosophic anarchist. After looking me over from head to foot, as if he expected to detect some hitherto unnoticed bulging of the pockets, indicative of dynamite bombs, he asked me what I meant, and sat in a wearied attitude (and my easy chair) while I told him. Now, said I, you know well enough that I would favor anything that I believed was fair and right, which would increase the output of your shop per man employed, and per dollar invested. But, as a result of considerable experience and observation, I firmly believe that shop rules are simply worse than useless. No rules ever made a good or valuable man out of a poor one, and no rules ever will or can do that. You may plaster the walls of your shop so thick with rules that there will be no room for whitewash, but nevertheless you will occasionally find on your pay-roll a man or boy who is simply good for nothing, and who is deficient in the natural intelligence or ambition necessary to make him of any value to you. Your only course, then, is to get rid of him, and keep on getting rid of all like him, until your shop is filled with men having sufficient intelligence to know for themselves, or to cheerfully and readily recognize when pointed out to them, the course necessary for them to pursue in order to become valuable men to you, and with ambition enough to pursue it. Men take their cue in working and conducting themselves largely from the general custom of the shop in which they work, and really pay precious little attention to rules.

Any man with the least intelligence can tell just what is required and expected of him during his first day's work in the shop, without once looking at the rules. He will do as the others do, and what the others do will depend not in the least upon the rules posted on the shop walls, but upon the kind of men you have selected and retained. You have already selected your foreman, and you believe him to be competent; but if he cannot tell whether or not a man is doing the fair thing, and will not in a quiet and gentlemanly way give to any delinquent a hint of what is expected of him, and then get rid of him as soon as he finds that intelligence or ambition is lacking, then you may conclude that you have made a mistake in the selection of your foreman, and had better get another one. If you have a chain which has one or two links in it that are too weak, the rest being all right, you simply strengthen the weak links, or replace them by others, don't you? Well, that is just what should be done with the men in a machine shop. The particular men who are not up to the standard required should be made to clearly understand that such is the case, and given an opportunity to work up to it; and it is folly to insult men who are already, and of their own accord, doing what is right, by telling them that they *must* do so and so, which they are already doing. If you follow the universal custom with your rules, you will of course have one which forbids talking among the men, except such as is necessary in connection with the work. No one who gets up a set of rules ever fails to have this one among them; but it is an absurdity, and never has nor ever will diminish the talking in a shop by so much as a single wag of the tongue. A really good man will find little time for conversation in the shop, but once in a while he will have a few words to say to somebody, and he will say them—rule or no rule. To put up a rule saying that he shall not do this is simply to insult him for no good purpose whatever, and it is far better to go directly to the men who make a practice of talking, and remind them that the shop is not a social club. This is for one rule; the others, relating to wasting materials, coming in late, etc., are equally useless. If you find your men doing these things, you may safely conclude that you have the wrong kind of a foreman or the wrong kind of men, or both. You may put up all the rules you can pay for having printed, but the reform of these evils will yet depend upon your foreman, who can reform them better without the rules if he understands his business. Now said I, I will give you the shop rules I shall post up in my shop.

To Employes: Gentlemen—

This shop was erected and is maintained for the purpose of building machinery; the main object of the subscriber being to make money by building it.

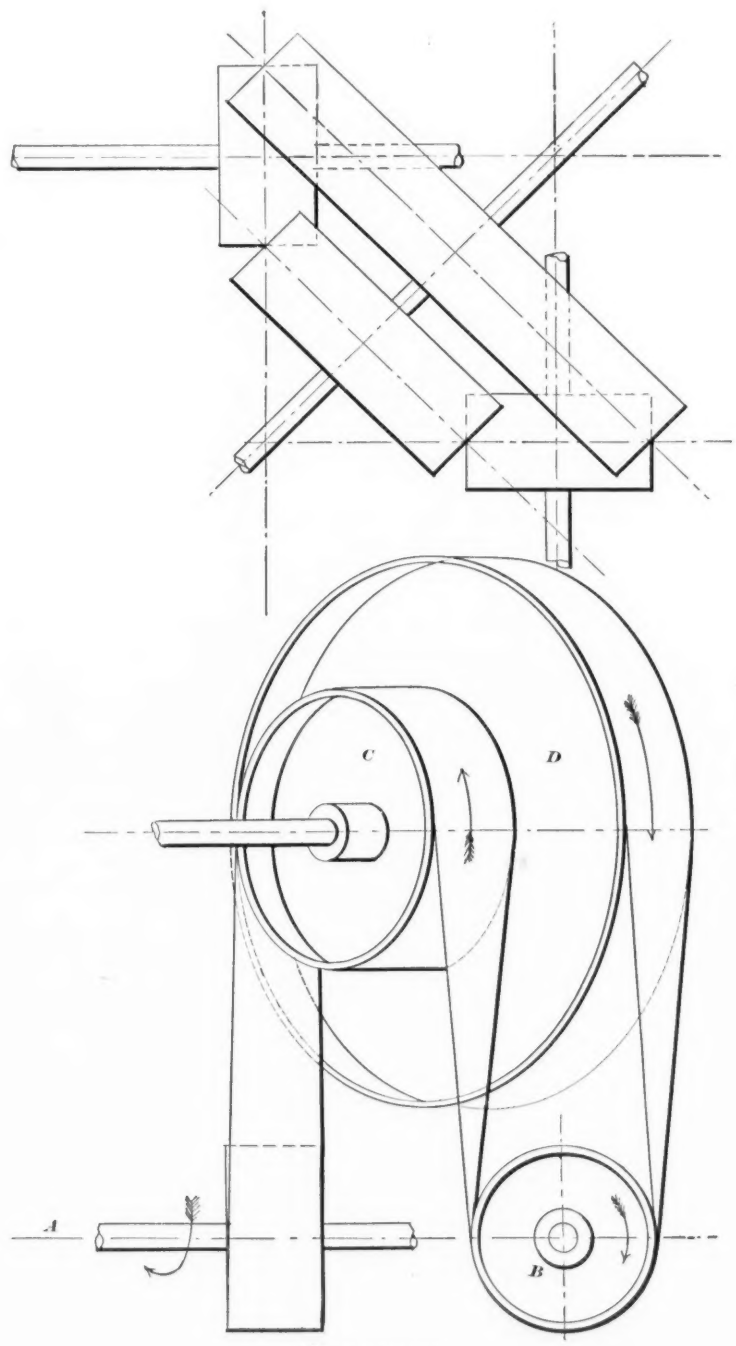
It will be the aim to secure men as workmen in this shop who possess intelligence and ambition enough to lead them to do that which is right and fair. On my part, and for my foreman and others in authority here, I agree to do the same as nearly as I possibly can, and hereby invite any employe who thinks he is not fairly treated to state to his foreman or to me the grounds of his belief.

Wages will be based upon the value of the services rendered; but whenever it is discovered that an employe lacks either the desire to do right or the intelligence needed to enable him to do right, his services will be considered of no value whatever.

T. A. Pandie, Proprietor.

My friend hasn't made up his mind yet what he will do about rules, and so has no rules, and won't have any until he decides what to have. But he has a good set of men, and it is my firm conviction that nothing would be more effective in making them less good than putting up a lot of "rules and regulations." I wouldn't even advise him to put up my own as given above now. I wouldn't put up any rules whatever. They are a humbug pure and simple.

T. A. Pandie.



Belt-driving.

To Bronze Brass.

Editor American Machinist:

I saw an article in last week's issue of the American Machinist, by J. Torrey, on nitrate of tin, brought out by a question you answered lately. I asked the question, and asked it simply because I could not get the article from any druggists in this city, Philadelphia or New York. I do not care to go to the trouble to make it, and am not chemist enough, anyhow, or to know what else may answer.

In the American Machinist of Dec. 20, 1888, Questions and Answers, a recipe is given to bronze brass to a dead black without heat, in which it says use one part nitrate of tin and two parts chloride of gold. I have need for such a solution, and can get the gold, but not the tin. Now, if Mr. Torrey can suggest anything else that will answer, I shall feel indebted to him.

Samuel T. Williams.

That Belt-driving Device.

Editor American Machinist:

Referring to the belt-driving device illustrated in your issue of the 13th March, and also to Mr. Wolcott's article thereon in the issue of the 27th, I have to say I used this same arrangement in the Union Iron Works of San Francisco in about the year 1867. I used a 10-inch belt on 48″ diameter of pulleys, the shafts being about 5 feet between centers, from which I had very great satisfaction. I do not claim to be the inventor of it, but I never saw it used or heard of it before that time. J. S. Detrick.

Highway Improvement.

The Engineering and Building Record, New York, some time since offered cash prizes for essays on road construction and maintenance. Twenty-one essays were presented on the subject, and a committee has awarded prizes to three of the contributors. The members of the awarding committee are well-known civil engineers, and men of special knowledge on road making. The three essays to which prizes were awarded will be published complete by our contemporary, while several others will be given in an abstracted form. The awarding committee will publish a criticism of all the essays submitted.

As long as children are raised in tenement and gutter the prisons will be full. The gulf between the rich and poor will grow wider. One will depend on cunning, the other in force. It is a great question whether those who live in luxury can afford to allow others to exist in want. The value of property depends, not on the prosperity of a very large majority. Life and property must be secure, or that subtle thing called "value" takes its leave. The poverty of the many is a perpetual menace. If we expect a prosperous and peaceful country the citizens must have homes. The more homes the more patriots, the more virtue, the more security for all that gives worth to life. The more real education, the less crime, and the more homes the fewer prisons.—*R. G. Ingersoll.*

A Boston correspondent writes us as follows:

The place for the young machinist to learn his trade, and the whole of it, is not in the complete city establishment, but in some country job shop in the wild and woolly West. Here is a specimen letter head from the Hoosier State:

THE EUREKA MACHINE WORKS.

Models, Patterns and Experimental Work.
Inventions Perfected.
Horseshoeing and General Repairing.

Anything, from developing a duplex mephistograph to tapping a keg of beer, can be learned in that shop.

The Delaware, Lackawana & Western Railroad has been in controversy with the State of New Jersey, for some years, in regard to taxes that the State claimed. Recently the claim has been settled entirely to the credit of the railroad.

AMERICAN MACHINIST

Communications relating to the reading columns should be addressed to the Editor. All other communications should be addressed:

AMERICAN MACHINIST,
96 FULTON ST., NEW YORK.

PUBLISHED WEEKLY AT
96 Fulton Street, New York.

Horace B. Miller, Pres't and Bus. Manager.
Lycurgus B. Moore, Treas. and Sec'y.

F. F. Hemenway, Editor and Mech. Engineer.
J. G. A. Meyer, } Associates.
Fred J. Miller, }

Special Announcements.

☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.*

Subscription.

$2.50 a year in advance, postage prepaid in the United States, Canada, and Mexico.
$3.50 a year to Other Countries, postage prepaid.

Advertising.

Transient, 35c. per line, each insertion.
"Business Specials," 50c. a line.

The American News Company,
Publishers' Agents, New York.
The International News Company,
11 Bouverie Street, Fleet Street, London, Eng., will receive subscriptions for the American Machinist, at 14/7 per annum, postage paid.

DEALERS SUPPLIED BY

The Albany News Company, Albany, N. Y.
The American News Company, New York, N. Y.
The Baltimore News Company, Baltimore, Md.
The Brooklyn News Company, Brooklyn, N. Y.
The Buffalo News Co., Buffalo, N. Y.
The Central News Company, Philadelphia, Pa.
The Cincinnati News Company, Cincinnati, Ohio.
The Cleveland News Company, Cleveland, Ohio.
The Colorado News Company, Denver, Colorado.
The Detroit News Company, Detroit, Mich.
The International News Company, New York, N. Y.
The Minnesota News Company, St. Paul, Minn.
The Montreal News Company, Montreal, Canada.
The National News Company, New York, N. Y.
The Newark News Company, Newark, N. J.
The New England News Company, Boston, Mass.
The New Orleans News Company, New Orleans, La.
The New York News Company, New York, N. Y.
The Northern News Company, Troy, N. Y.
The Omaha News Company, Omaha, Neb.
The Pittsburgh News Company, Pittsburgh, Pa.
The Rhode Island News Company, Providence, R. I.
The San Francisco News Co., San Francisco, Cal.
The South West News Company, Kansas City, Mo.
The St. Louis News Company, St. Louis, Mo.
The Toronto News Co., Toronto, Ontario, Canada.
The Toronto News Co., Clifton, Ontario, Canada.
The Union News Company, New York, N. Y.
The Washington News Company, Washington, D. C.
The Western News Company, Chicago, Ill.
The Williamsburgh News Co., Brooklyn, E. D., N. Y.

NEW YORK, APRIL 17, 1890.

CONTENTS.

PAGE.
Independent Condensers for Marine Engines.... 1, 2
Mills and Mill Engineering 2, 3
Furnace for Melting Babbitt Metal..... 3
Suspended Radial Drill..... 3
Odontics, or the Theory and Practice of the Teeth of Gears. By George B. Grant 4, 5
The Modern Steam Plant and its Management. By Peter H. Bullock..... 5, 6
Forty-eight Inch Radial Drill..... 6
Letters from Practical Men: Novel Form of Whetstone. By W. H. Booth—Pumping Water to an Abnormal Height. By Peter H. Bullock—Pumping Water More Than 34 Feet High. By Geo. J. Mashek—Another Quarter-turn Belt Substitute. By P. J. Fickinger—Shop Rules. By T. A. Pandie—To Bronze Brass. By Samuel T. Williams—That Belt-driving Device. By J. S. Detrick 6, 7
The Unexpected.... 8
Machinery Not at Fault..... 8
Wild and Weird..... 8
Literary Notes 8
Questions and Answers..... 8, 9
Manufactures 9
Machinists' Supplies and Iron..... 10

The Unexpected.

At this writing it is impossible to comment intelligently upon the accident to the "City of Paris" from an engineering standpoint, for the reason that so many things appear in the reports which are either manifestly untrue upon their face, or inconsistent with other statements sometimes appearing in the same report. But we are at least reasonably certain that, by some accident which occurred to one of her engines, water in large quantities was admitted to some of her compartments, and that not only the engine which was wrecked, but the other one also, was rendered for the time being useless. It seems also to be reasonably sure that no steam pumps were available at the time when most needed—at least none that were of sufficient capacity to be worth mentioning—and that, had the ship been constructed as many others are, she would now almost certainly be at the bottom of the sea. When the vessel was put into service, it was freely claimed that she was practically unsinkable—a claim which of course has by no means been disproved, but rather strengthened. But, besides her water-tight bulkheads rising eighteen feet above the water line, it was pointed out, as an additional and important feature of safety against foundering, that at least one engine and its screw would always be available for controlling and handling the vessel, so that she could not become utterly helpless. It is somewhat remarkable that this claim has been so thoroughly disproved, we might say almost at the outset of her career.

It is altogether probable that the "City of Paris" is as safe as any vessel afloat, and far more safe than the majority of them; but it is questionable if the time will ever come when it can be said that a vessel has been constructed in which there is absolutely no risk. The saying, that "it is the unexpected that always happens," was perhaps never better illustrated, than by this accident. An apparently insignificant or undiscovered flaw, the presence of which no one could have been aware of, might easily have been the cause of this accident, which not only disabled the engine in which the break occurred, but the other one separated from it by a bulkhead especially designed to prevent both engines being disabled at the same time. We do not yet understand how it could happen that the vessel could be so suddenly rendered absolutely helpless; but we hope the matter will be fully explained. The public have been free to accord to the builders and owners the credit and honor of producing a ship representing the highest achievement in that line; the company now owe it to humanity to make it plainly known just where the weak link was, that it may be guarded against in future. It seems altogether likely that the presence of this weak link was something which, with the present limitations of human prescience, could not have been provided against, and therefore was not discreditable; but if it was something which this accident makes it possible to provide against for the future, it will be discreditable to withhold a full explanation. If it is true, as reported, that the "City of Paris" will not be ready for use again this season, the loss to her owners, aside from the cost of repairs, will of course be very heavy, and altogether it is an occurrence which they must have every reason to regret, and which it is safe to say they will use every possible means to prevent a recurrence of.

Machinery Not at Fault.

There is in some quarters an apparent inclination to discredit the reports reaching us through the daily press regarding the distress among the coal miners of Pennsylvania, and, indeed, when one thinks of it it does seem almost incredible that, in our free America, men, women and children are actually starving in the midst of such plenty as the world has scarcely seen heretofore. But that it is true can no longer be doubted when it is made known that public meetings of citizens living in the mining regions are being held, to devise means of relief, and that people who in the nature of things must be familiar with the whole melancholy business are contributing to the support of families whose natural providers seem, by some infernal alchemy, to be deprived of the power of working for their support upon the raw materials which are all about them in abundance.

And it is to be remarked that men do not submit to starvation for themselves and families for trifling causes. It is the last resort, even in Russian prisons, where the "hunger strike" proves the most efficient, though the last means of securing some mitigation of cruelty.

While it is not true that the world owes any man a living, it is true that the world owes to every man an opportunity of fairly earning his living. Any one who looks about him can see that nature herself yields an abundant return for labor, even of the most rudimentary kind, and all our machinery, and improvements in methods and processes simply tend to cause a still more abundant return. To say that this abundance is in itself a curse, and that the only way to rid ourselves of it is to get rid of the machinery, is not only absurd upon the face of it, but is disproved by the facts of history.

The problems connected with this question closely concern every citizen, and it is folly to say that "nothing is the matter," "every one who really tries can be prosperous," "there is always room at the top," etc. It is well to remember that some one must always be at the bottom, or there can be no foundation, and, laying all questions of humanity aside, it has been pretty clearly shown that the continued and permanent prosperity and happiness of those at or near the top depends mainly upon the degree of contentment and prosperity of those at or near the bottom.

Wild and Weird.

It is to be observed that no newspaper reporter who understands anything of his business ever fails to ring in the "wild, long, weird blast of the whistle" in his accounts of the remarkable performances of locomotives. When the "bold engineer, with his eagle eye on the rail," concludes to run a race with a cyclone, or anything of that sort, he doesn't simply look to his water and steam gauge, open the throttle and "let her go"; by no means; he first attempts to rattle and discourage the cyclone, not by pulling the whistle lever in the ordinary way, but in such a manner as to impart that element of wildness and weirdness which seems to be necessary on such occasions. How he manages to do this we are at a loss to understand, and we doubt if the engineer himself could explain it; but that he does it there can be no reasonable doubt, for, have we not the testimony of many newspaper men who have recorded the history of such exploits, and not one of them, so far as we can remember, has failed to mention that a "long, wild, weird blast" was blown as a preliminary to the proceedings.

According to a press report, M. Chanteloup, who is described as a well-known brass founder in Canada, has set an example which, no doubt, many of our readers will hope may lead to similar actions becoming fashionable. He left his fortune, estimated at $500,000, to be divided among his former employes. We don't know how it may be in Canada, but if such a thing should be done in this country, it is perfectly safe to say that relatives would turn up who would succeed in proving that the testator was insane, and, if they did not prevent a division of the money entirely, would delay it so long that most of the employes would be dead or independently wealthy themselves, and the lawyers would have the five hundred thousand.

Literary Notes.

We have received a copy of the tenth edition of Spons' Tables and Memoranda for Engineers, by J. T. Hurst.

This, we believe, is the smallest publication containing the tables and memoranda most frequently used by mechanics and engineers, its size being $2\frac{5}{8}''$x$1\frac{7}{8}''$, and $\frac{1}{4}''$ thick The fact of its having reached the tenth edition is evidence of the fact that its convenience and usefulness have met with appreciation. The publishers are E. & F. N. Spon, New York. Price, 40 cents.

The April number of the Journal of the Franklin Institute contains the report of the Committee on Arts and Sciences regarding what is called a system of Sanitary Entombment. By this system bodies of the dead are placed in vaults or cells of concrete, through which air that has previously been deprived of all moisture is forced, the air then passing through burning fuel to the atmosphere. The report of the committee is very favorable, and they recommend that the John Scott Legacy Premium and Medal be awarded to it.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(141) W. M. S., Duluth, Minn., asks: Should the intermediate crank of a triple-expan, sion engine follow or precede the high-pressure crank? *A.*—The general practice is to make the intermediate crank follow the high-pressure crank.

(142) K. G., Brooklyn, asks: Will you please explain what Mushet steel is, and how it is made, and how the temper is put in it so it will not lose it when heated? *A.*—Mushet's steel is a tungsten steel, the tungsten being derived from its principal ore—wolfram. Prof. Thurston, in his "Materials of Engineering," says it is thus made: Pulverized wolfram is mixed with its own weight of pitch; this mixture is added to the iron and flux in the crucible, and the whole is then melted in the steel furnace at a high heat.

(143) G. D., Philadelphia, asks: Is it pos sible to case-harden Bessemer steel or wrought-iron to the depth of $\frac{1}{8}$ inch, or sufficiently deep to permit of being ground true by emery wheels? Say a piece about 4 inches diameter. If it is, what are the materials used, and the method? *A.*—Such pieces can be case-hardened to a sufficient depth to admit of grinding true. It is done by packing them in cast-iron boxes with bone charcoal, and keeping at a bright red heat from 12 to 24 hours. The depth of the hardening will depend mainly upon the quality of the iron and the length of the heat.

(144) V. B., asks: Will you inform me the correct way to cut a double thread? *A.*—Cut one thread in the ordinary manner, and then adopt any convenient method for turning the screw just half a revolution without moving the tool, or of advancing the tool half the lead of the screw being cut without moving the screw. If the stud turns at the same speed as the lathe spindle, and the change wheel on the stud has an even number of teeth, a very convenient way is to mark two teeth which are together in this gear and the one it drives. Mark the tooth opposite to this, and, by means of the swinging arm disconnect the gears and turn the lathe spindle so as to bring the other marked tooth into contact with the marked tooth of the intermediate. Where much of such work is to be done, however, it is more expeditious to have a driver bolted to the face-plate which has two lugs on it for the dog to come against, the lugs being just opposite, or 180° from each other. Your other question is answered elsewhere in this column.

(145) H. G. W., Birmingham, Ala., writes: We are erecting four boilers, 30 feet long and 54 inches diameter; two flues, 18 inches diameter, set in batteries of two. What would be the proper grate area? *A.*—Assuming that the given diameter of the flue is the inside diameter, the total cross-sectional area of the two flues will be 3.52 square feet. The grate area in each boiler is generally made equal to six to ten times the total cross-sectional area of the flues; making the grate area equal to seven times the cross-sectional area of the flues, we have 24.64 square feet of grate area for each boiler. The heating surface of each boiler is about 600 square feet, which gives us

$$\frac{600}{24.64} = 25.97,$$

say 26 square feet of heating surface to each square foot of grate surface. Since the practice is to allow from 25 to 30 square feet of heating surface per square foot of grate, we conclude that 24.64 square feet of grate in this particular case is about right. Although it is always good practice to make the grate surface equal to eight times the cross-sectional area of the flues, the proportion of seven to one adopted for these boilers will probably give

better satisfaction because the ratio of grate surface to heating surface agrees closer with the average practice. 2. What should be the diameter and height of the chimney, using bituminous coal for fuel? *A.*—Assuming that 15 pounds of coal per hour per square foot of grate are burnt, the total amount of coal burnt per hour will be $4 \times 24.64 \times 15 = 1,478.40$ pounds. Looking for this amount of coal in the table of chimney proportions published in our issue of April 23, 1887, we find that we need a chimney 48 inches diameter, and 100 feet high. 3. If we should use furnace gas for fuel, would the dimensions of the chimney be changed? *A.*—We should not change them.

(146) L. L., New York, asks: 1. What should be the diameter and pitch of propeller for an engine with cylinder 4 inches diameter and 6 inches stroke, piston speed 200 feet per minute, boiler pressure 75 pounds? *A.*—Diameter of propeller, 24 inches; pitch, 42 inches. 2. What speed could be obtained with this engine for a boat 16 feet long? *A.*—We cannot give the speed, because you have not given the width and draught of boat. If it is an ordinary steam launch, the engines are too large for the given length of boat. If the width of the boat is about 4 feet 6 inches outside, depth 2 feet, we should use a cylinder 2 inches diameter, 3 inches stroke, 450 revolutions; diameter of propeller 12 inches, and pitch 21 inches. The speed of this boat will be about 6 miles an hour, depending on the lines of the boat and the load carried. 3. I intend to build a steam launch for my own use; what rules according to law will I have to obey? *A.*—Apply at the office of the Board of Supervising Inspectors of Steam Vessels, Post Office Building, New York City, for laws governing the steamboat inspection service.

(147) A. D. S., Jacksonville, Fla., writes: Please inform me what is the average evaporative capacity in pounds of water per square foot of heating surface of the following types of boilers under natural draught: Horizontal tubular boiler, fire-box or locomotive tubular boiler, upright tubular, Scotch marine boiler, and return tubular boiler. *A.*—The evaporative capacity of the heating surface will depend on its character and location in the boiler, and varies considerably. Hence, for comparison, the heating surface as a whole in the different types of boilers must be taken. The following table gives an approximate list of square feet of heating surface per horse-power in different types of boilers, and other data for comparison:

Type of Boiler.	Square Feet of Heating Surface per One Horse-power.	Hard Coal per Square Foot of Heating Surface per Hour.	Relative Economy.	Relative Rapidity of Steaming.	Authority.
Water tube..	10 to 12	.3	1.00	1.00	Isherw'd
Tubular.....	14 to 18	.25	.91	.50	"
Flue	8 to 12	.4	.79	.25	Trowb'ge
Plain cylinder.....	6 to 10	.5	.69	.20	
Locomotive.	12 to 16	.275	.85	.55	
Vertical tubular.....	15 to 20	.25	.80	.60	

(148) H. L. D., Hornellsville, N. Y., asks: What is the customary allowance for shrinkage for a locomotive driving wheel tire 5 feet 2½ inches diameter? *A.*—In 1886 the American Railway Master Machanics' Association recommended and adopted the following standards:

Diameters of Wheel Centers.	Inside Diameters of Tires.
38 inches	38 inches less 0.040
44 "	44 " " 0.047
50 "	50 " " 0.053
56 "	56 " " 0.060
62 "	62 " " 0.066
66 "	66 " " 0.070

2. Will a tire 3 inches thick expand or shrink any more than a tire 1½ inch thick, both being heated to the same temperature, and of the same diameter inside? *A.*—The difference will be so small that in practice we may consider the expansion or shrinkage to be the same in both tires. 3. From what standpoint do you calculate the length of a link or the travel of the link block? *A.*—They are measured on the center line of link; that is, on an arc drawn along the center of opening of the link. 4. How many square feet of heating surface does it require to make a horse-power? In locomotives the heating surface is not proportioned according to the horse-power. A good rule is to allow 400 square feet of heating surface per cubic foot of one cylinder. Many locomotives have less heating surface. For other boilers there is not a regular standard; some boiler makers allow 15 square feet of heating surface per horse-power, others as low as 10 square feet. 5. How do you compute the horse-power of a boiler? *A.*—Sometimes the horse-power of a boiler is found by dividing the total heating surface by 15; the quotient will be the horse-power. The most satisfactory way to find the horse-power of a boiler is to determine the amount of water which it can evaporate per hour. 34½ pounds of water evaporated at and from 212 degrees per hour is considered to be one horse-power. 6. In starting an injector, how does the water lift the check valve? Is the action of the water a hammer blow on the valve? *A.*—The lift of the check valve is due to the velocity of the feed water. There is no hammer blow in connection with it.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Lexington Cut Iron Gears. See adv. on p. 16.

Link-Belting and Sprocket Wheels.

Send for Catalogue of Link-Belting.

Over 50,000,000 feet of Link-Belt in use.

Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

"How to Keep Boilers Clean." A 96-page book mailed free by Jas. E. Hotchkiss, 120 Liberty st., N.Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Universal Vise Chucks. Pedrick & Ayer, Philadelphia, Pa.

Link Planer Attachments. Pedrick & Ayer, Philadelphia, Pa.

Whiton's Chucks. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Steel Name Stamps, etc. Address W. G. Sackmann, 1099 First ave., Cleveland, O.

Get particulars of our new Wall, Suspended and Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Audubon Machine Works, New Haven, Conn. Special machinery, heavy and light.

For the Latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

Send $1 for Catalogue D, Fine Tools and Supplies. Over 550 pages. Fully illust'd. Free when $10 worth goods are ordered. Frasse & Co., 92 Park Row, N.Y.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

The Sure Grip Steel Tackle Blocks must fill the bill, according to the large sales reported. See advertisement, page 13.

Watch this column for our Weekly Announcement of Bargains. Selling Overstock. McFadden Co., 1025 Market st., Philadelphia, Pa.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See April 10, p. 11. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Patents.—Patent soliciting of high class. D. Walter Brown, 31 Nassau st., New York. Send for "A Brief History of Patent Legislation in the United States."

25" 28" 32" 36" Upright Drills a specialty. Finely made, great capacity, quickly operated, prices low. Send for list of firms using our Drills. J. E. Snyder, Worcester, Mass.

25" 32" 37" 42" "Only Drill Press built on 'Ko-rekt' principles, even if they come from Jersey." Gould & Eberhardt, New Ark, N. J.

C. H. Redman & Co., Newark, N. J., Manufacturers of Light Machinery, Automatic Selling Machines, Telephone and Telegraph Instruments, Sewing Machine Attachments, Models, etc. Contracts solicited.

For Sale—Bound volumes of the Patent Office Gazette for years 1879, 1880, 1881, 1882, 1883, 1884, 1885, 1886, 1887 and 1888. Price, $4 per volume. Address J. C., care of AMERICAN MACHINIST.

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations. 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting Rods for small connections. Especially adapted for Valve Rod for Steam Engines. T. C. Dill Machine Co., Philadelphia, Pa.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't De Lamater Iron Works, will hereafter manufacture the De Lamater Screw Propeller. Propellors of same patterm and workmanship as formerly made by the De Lamater Iron Works. Each designed for its special work at lowest prices. Consulting Expert and Construction Engineer. Estimates made on machinery and on damages.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

MANUFACTURES

The Oshkosh Iron Pump Works, of Oshkosh, will erect a brass and iron foundry at Kokomo, Ind.

The Western Furnace Co., Manistique, Mich., has been incorporated, to build a blast furnace.

C. B. Albree, Allegheny, Pa., manufacturer of ornamental iron work, is materially increasing his plant.

Permission has been given by the authorities of Waltham, Mass., for the use of electric cars by the Newton Street Railway Company.

A grain elevator with a capacity of 100,000 bushels, and a roller mill with a capacity of 200 barrels, are to be erected at Vernon, Texas.

The Diamond Clamp and Flask Works, of Richmond, Ind., have recently received an order from Manchester, England, for a number of their clamps and flasks.

It is said that a company has been formed in Cincinnati, Ohio, with a capital of $500,000, to manufacture cast-iron pipe, and will locate at Brighton, a suburb of Cincinnati.

The Pond Machine Tool Works at Plainfield, N. J., are to be enlarged at once by the addition of 200 feet in length to the main building, which will make it 706 feet in length.

C. W. LeCount, South Norwalk, Conn., has issued a new and revised price-list of lathe dogs, clamps, wrenches, expanding mandrels, drill holders, and other tools made by him.

Hardwick & Ware, manufacturers of engineers' and plumbers' supplies, Buffalo, N. Y., write us: "We are building a new five-story factory on Washington street, 55x132 feet, and expect to move in about October 1."

The Blake Manufacturing Co. has completed its new works at Cambridgeport, Mass. The main shop is 100x400 feet, arranged with a gallery at each side. A 15-ton Sellers traveling crane covers the main space.

The Bay State Furnace Co., recently organized at Fort Payne, Ala., has nearly all stock subscribed, and will at once break ground for the building of its iron furnace. C. O. Godfrey is president, and H. B. Hill, manager.

An effort is being made by the Lewiston (Maine) Board of Trade toward a movement to buy up the Lincoln mill property, and the adjoining Lincoln block, for the purpose of fitting them up for small manufacturing industries.

Vanderburgh, Wells & Co., makers of pattern and brand letters, will, on or before May 1, remove from their present location, corner of Fulton and Dutch streets, to No. 8 Spruce street, near Nassau street, New York.

The J. T. Case Engine Company, New Britain, Conn., send us a catalogue describing and illustrating the engine made by them. The engine is very completely illustrated in the catalogue, and its desirable points are well explained in the text.

Work has begun on an enlargement of the Plymouth Woolen Mill, Plymouth, Mass. It will add two stories to the dye house wing of the building, making two large rooms, 75x50 feet, in which other branches of the mill business will be accommodated.

The Acme Machinery Company, Cleveland, Ohio, send us a catalogue and price-list of bolt cutters, bolt headers, nut tappers, and other special machinery made at the works. The catalogue contains information of both a special and general character.

Curtis & Curtis, Bridgeport, Conn., have brought out a new die stock for hand power that has a range from two and a half to eight inches inclusive. While entirely portable, this tool is so strongly back-geared that one man can cut eight-inch pipe with ease.

Palmer, Cunningham & Co., 607 Market st., Philadelphia, Pa., have issued an 1890 catalogue of specialties. The catalogue illustrates hoists, fire pails, oil cabinets, speed indicators, machinists' small tools, pipe fitters' tools, and other things of interest to mechanics and manufacturers.

The Niagara Screw Co., Buffalo, N. Y., are starting in the manufacture of set and cap screws. F. M. Clarkson will be business manager. Capacity will be increased to any extent demanded by business. Mr. Clarkson was for many years similarly connected with one of the leading screw companies.

The Corliss Steam Engine Company, Providence, R. I., is shipping to South America a triple-expansion engine of 1,000 horse-power; also two tandem compounds of 150 horse-power each. The company has under way a 400 horse-power triple-expansion engine. The works of this company have been entirely reorganized, and work in all departments is pushing.

The new buildings of the Knowles Loom Works, Worcester, Mass., are about completed. The main building contains 144,000 feet of floor space. The foundry will have a capacity of twenty tons per day. In addition to these buildings there is a blacksmith shop, engine-room, boiler house and carpenters' shop.

Henry R. Worthington, 86 to 88 Liberty street, New York, has issued a new general catalogue of steam pumping engines, steam pumps and hydraulic machinery, also a special catalogue of the Worthington independent condenser. There is a good deal of information in these catalogues of interest to engineers and manufacturers.

The Squirrel Hill Brick and Tile Company is the name of a new corporation which will build a plant at Oakland, Pa. The company has purchased the machinery of the old Encaustic Tile Company, of McKeesport. H. Collins, formerly manager of the works at Elrods, has been elected president and manager of the new company.

The Baker Wire Company, of Chicago, Ill., and the Joliet Enterprise Company, acting under the title of the Western Wire Company, will at once erect a wire rod mill in Joliet, and later a wire mill, a nail mill, and possibly a steel converting plant. The new concern will have its general office in the Rookery Building, Chicago.

The Stover Manufacturing Company, of Poughkeepsie, N. Y., announces to the trade that it has purchased from the Edward Storm Spring Company, of the same city, the hardware specialty department of the latter's business. It is the intention of the purchasers to remove the works to New Jersey, and largely increase its facilities.

The New York City Bolt and Nut Co., Limited, is the name of a new firm incorporated to be located at 35 Desbrosses street, New York City. The company will manufacture machine bolts and nuts of every description; plant to be in operation about the 1st of May. The Garvin Machine Co. have equipped these works with the most modern machine tools for their tool-room.

A local paper has this to say: "The Whitaker Engine and Skein Co. [Kenosho, Wis.,] is now just what the name would imply. Mr. R. B. Whitaker has bought out all the stockholders, and now he and his sons, R. S. Whitaker and T. B. Whitaker, own the entire stock of the company. That is as it should be, and every one will be glad to learn that they have succeeded in getting possession of the whole stock."

A project is on foot to dig a ship canal from a point opposite Grand Island, in Lake Superior, to the northern extremity of Green Bay in Lake Michigan, cutting across the narrowest part of the long peninsula between those two lakes. The proposed canal is to be thirty-six miles long, and would save two days and a half for steamers and five days for sailing vessels that would otherwise have to go around the peninsula.

The Pennsylvania Diamond Drill and Manufacturing Company, Birdsboro, Pa., has built, from the designs of Wm. Durfee, manager, a boring machine that will bore from one inch up to 22 feet in diameter, and will turn pulleys up to 22 feet diameter and 12 feet face. The height of the machine is 23 feet 6 inches, and the floor space occupied is 690 square feet. The machine has 48 changes of speed and 96 changes of feed, and weighs 108,000 pounds.

The first steel vessel built in the Saginaw Valley was launched at Wheeler's shipyards Tuesday. The boat is the City of Chicago, is owned in Chicago, and will run between that city and Benton Harbor. She is 213 feet long, has 70 state-rooms, and is supplied with every modern convenience. The cost will reach $220,000. No less than 15,000 persons saw the launch, excursion trains carrying several hundred strangers to see the sight.—*Mining Journal*, Marquette, Mich.

A press dispatch from Corry, Pa., is to the effect that Chicago capitalists have completed arrangements for the establishment of a large aluminum plant at that place. Beds of clay north of the city have been discovered and thoroughly analyzed, and pronounced very rich in aluminum. The company, represented by Col. Dorrance, formerly of the Texas Pacific Railroad, has entered into bonds in the sum of $10,000 to expend $50,000 the coming season in developing the beds.

Fourteen acres of land were recently purchased on the Calumet river, near South Chicago, Ill., by S. F. Eagle, of Youngstown, Ohio, as a site for a blast furnace. A number of Pittsburgh capitalists are associated with Mr. Eagle. The land purchased has an extensive frontage on the Calumet river, which is navigable for lake vessels, enabling them to discharge Lake Superior ore on the furnace docks. Railroad facilities are also secured with the property. Contracts are to be made at once for the erection of the furnace.

Preparations for building the two gunboats at Bath [Maine] are already under way. Some of the piles which are to serve as a foundation for the blocking which will support the gunboats, have arrived, and a crew are driving them into place. One thousand piles must be set, and the work will occupy several weeks. The appliances for manipulating the metal for the vessels are being constructed, and iron shipbuilding may be said to be actually under way in Maine. At the foundry of the Bath Iron Works the moulds for the floor plates are being made. These are thick plates of iron, five feet square, filled with square holes for the insertion of stout pins. Sixty of these plates will be cast and then bolted firmly together, forming a perfectly plain iron floor, containing 1,500 square feet.—*Industrial Journal.*

Machinists' Supplies and Iron.

NEW YORK, April 12, 1890.

Iron—American Pig.—On Wednesday of this week the Thomas Iron Co. reduced their quotations to $18 and $19 for Nos. 1 and 2 Foundry, but the cut seemed to be without marked effect upon the market, one reason being that it was not as much reduction as many had expected to be made.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Draftsman on heavy machinery wants work. Good references. Address "Detail," AMERICAN MACHINIST.

Engineers, iron founders and machinists. Exp'd bookkeeper solicits work. B., 614 Court st., B'klyn.

Wanted—A few first-class machinists. Best of refs. required. Apply to Munson Bros., Utica, N. Y.

Wanted—Position as assistant draftsman or tracer. Coleridge, Box 10, Bucyrus, Ohio.

Foundry foreman wants a position. Long experience, good references. Foundry, AM. MACHINIST.

Wanted—Position as foreman of machine shop in the vicinity of N.Y. Exp'd in marine, stationary engines and gen'l machinery. Hustler, AM. MACH.

Wanted—Good general machinists to work on Corliss engines, ice and refrigerating machinery. Frick Company, Waynesboro, Franklin Co., Pa.

Wanted—Position as traveling salesman by first class tool maker experienced in general machinery business. P., care AMERICAN MACHINIST.

Wanted—One first-class pattern maker on machine tools; none but competent man need apply. Address P. O. Box 1527, Fitchburg, Mass.

Situation wanted as engineer. First-class references. Can do repairing and pipe fitting. Address Engineer, P. O. Box 663, Plainfield, N. J.

Wanted—Position as assistant draftsman by a foreman pattern maker 30 years of age. Address P. J. AMERICAN MACHINIST.

Position wanted as ass't mechanical draftsman, by a young man with some exp., and a graduate of a manual training school. Refs. M. A., AM. MACH.

Draftsman Wanted—One having architectural and machine exp. preferred. Also a few 1st-class machinists for tool-room. Buffalo Forge Co., Buffalo, N. Y.

Machinists Wanted—First-class vise and machine hands of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, Ohio.

Situation wanted by practical draftsman and machinist. Thoroughly posted in power transmitting machinery, also designing special and experimental machines. Address W. A. R., AMERICAN MACHINIST.

Brass Moulder Wanted—Thoroughly accustomed to mixing metals. Class of work mostly steam, water and gas goods. Address, stating age, exp., and wages exp'd, J. Q. Adams, P. O. Box 51, Buffalo, N. Y.

Mechanical draftsman, age 26, technical school graduate, with 9 years' experience in mfg. and designing of machinery, wishes permanent situation. N. Y. City or vicinity preferred. Box 3, AM. MACH.

Wanted—A first-class tool maker and machinist would like to make a change about May 1. West preferred. Best of references. Address Box 4, AMERICAN MACHINIST.

Wanted—At once, 1st-class pattern makers familiar with heavy engine and machine work. Steady work and liberal wages guaranteed. Chester Foundry and Machine Co., A. E. Jenkins, Gen'l Manager, Chester, Pa.

A member of the A. S. of M. E., with 12 years' experience in the design, construction and management of modern steam plants and general machinery, wishes to correspond with builders in need of sup't or engineer. Best references and reason for wishing to change present location. Address Engineer, care AMERICAN MACHINIST.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d-h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, Ohio.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Highly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Castings of every description and machinery built. Address Cedar Point Foundry, Port Henry, N. Y.

Inventions perfected; experimental work; fine tools, dies & light mach'y. C. Wadsworth, 90 Fulton st., N. Y.

Wanted—Customers for our new Radial Drills. C. H. Baush & Sons, Holyoke, Mass.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Inventions or improvements in measuring instruments & other fine tools wanted to manufacture & sell on royalty. "Tools," AMERICAN MACHINIST.

Simonsen-Walter Mfg. Co., Jefferson City, Mo., with modern foundry, machine and wood-work plant, wants spec. to manuf. for Western trade.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

How to remove and prevent scale in steam boilers at a cost of ten cents a week. Send postal for circular to Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

Patentees having some novel invention in light hardware or machinery which they desire to have m'f'd on royalty, or to sell outright, are requested to address the undersigned, who have a well-equipped machine shop. Manufacturer, Box 1945, N. Y. City.

For Sale—Machine shop and foundry in City of Big Rapids; population, 7,000. Also an electric light plant of 40 arc lights. Water-power unequaled in the State. Prosperous and well established business. Estate must be settled up is reason for selling. For particulars address Lois A. Hudnutt, Administratrix, Big Rapids, Mich.

BRADLEY HAMMERS AND FORGES.

The BEST HAMMERS in the WORLD RUN BY BELT.

Over 1500 In Use.

Three Styles, 15 lb. to 500 lb. Heads.

Our FORGES heat irons fast enough to keep Hammers and men fully employed.

Send for Catalogue and Prices.

BRADLEY & COMPANY, Syracuse, N. Y.

63 Murray St., NEW YORK. 98 Sudbury St., BOSTON.

TWENTY YEARS WITH THE INDICATOR.

Being a Practical Text-Book for the Engineer or the Student, with no complex formulæ, and with many Rules as to the best way to run any Steam Engine to get the Most Economic Results—How to Adjust Valves and Valve Motions, with Directions for Working up Horse Power—Amount of Steam or Water per Horse Power—Economy of Fuel—Directions for Attaching the Indicator—Motions to Use and Not to Use—How to Compute by Planimeter or Without, etc., etc. By Thomas Pray, Jr., Consulting and Constructing and Civil and Mechanical Engineer, etc., etc. Seventh thousand (1888). Newly arranged and complete in one volume Royal 8vo, cloth.....$3 00

"It is a very thorough work, and appears to be amply sufficient for the guidance of the practical engineer and the information of the intelligent engine-builder or the manufacturer."—*Scientific American.*

JOHN WILEY & SONS, 53 E. 10TH ST., NEW YORK.

PRESSES, DIES AND OTHER SHEET-METAL TOOLS

FERRACUTE MACHINE CO. BRIDGETON, N. JERSEY, U.S.A.

L. S. STARRETT, Manufacturer of FINE TOOLS, ATHOL, MASS.

SEND STAMP FOR FULL LIST.

"Star" Foot Lathe Swings 9x25 in.

LA LATHE HE

Screw Cutting Automatic Cross Feed, etc.

Scroll Saws, Circular Saws, Lathes Mortisers.

Catalogue Free of all our Machinery.

Seneca Falls Mfg. Co. 687 Water St., Seneca Falls, N.Y.

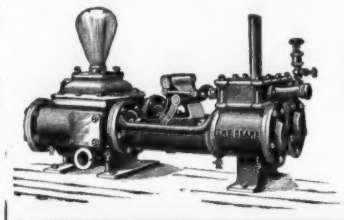
DEPARTMENT OF THE INTERIOR.
WASHINGTON, March 13, 1890.

Sealed proposals for erecting an engine house and impounding reservoir, furnishing pumping engines and boilers, cast and wrought-iron piping, special castings, fittings, valves, lead, jute, and for erection and performing the work necessary to complete the pumping station on the Hot Springs Reservation, at Hot Springs, Ark., will be received at this Department until 12 o'clock M., Wednesday, April 30, 1890, when they will be opened. Blank forms of proposal, embracing specifications, together with drawings showing details, may be obtained upon application to the Department, or the Superintendent of the Reservation at Hot Springs, Ark. JOHN W. NOBLE, Secretary.

DROP FORGING.

SPEIRS & MOORE, WORCESTER, MASS.

IMPROVED PUMPING MACHINERY | For Every Class of Work | Send for New Illustrated CATALOGUE.



THE DEANE OF HOLYOKE

STEAM PUMPS

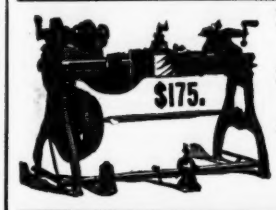
DEANE STEAM PUMP CO., HOLYOKE, MASS.

BEST STEEL

For Taps, Dies, Punches, Milling Cutters, Lathe and Planer Tools, Cold Chisels, Edged Tools and Hardware of all kinds.

CRESCENT STEEL CO., 136 FIRST AVE., PITTSBURGH, PA.

64 & 66 So. CLINTON ST., CHICAGO, ILLS. 180 PEARL STREET, NEW YORK, N. Y.



Improved Screw Cutting Foot and Power LATHES

Drill Presses, Shapers, Band, Circular and Scroll Saws. Machinists' Tools and Supplies. Lathes on trial. Catalogue mailed on application.

THE SEBASTIAN-MAY CO., 167 W. 2d St., CINCINNATI, O.

MONTGOMERY & CO., 105 Fulton St., New York, Gen'l Agents.

TOBIN BRONZE

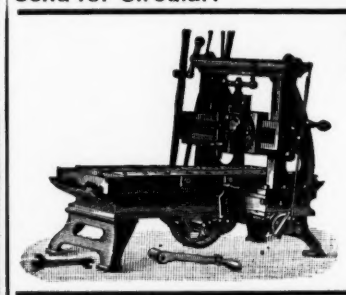
Tensile Strength upwards of 79,000 lbs. per sq. in.
Torsional Strength equal to the best Machinery Steel.
Anti-Frictional and Non-Corrosive.

CAN BE FORGED HOT.

Rods for pumps and bolts. Yacht shafting. Rolled sheets and plates for pump linings and condenser tube sheets, &c. Ingot metal for car and engine bearings. Spring wire.

ANSONIA BRASS & COPPER CO., Sole Manufacturers.

Send for Circular. CHICAGO. NEW YORK.



SMALL POWER OR HAND PLANER.

FOR ANY SMALL WORK.

Weight of Platen 100 lbs.

A. J. WILKINSON & CO., 184 Washington St., BOSTON, MASS.

SEND FOR CIRCULAR.

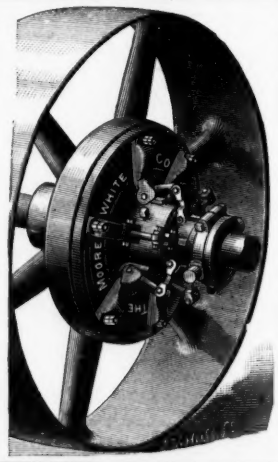
PATENTS.

During March, April and May my fees due only on allowance if desired. Write

WM. H. BABCOCK, 513 Seventh St., Washington, D. C., P. O. Box 290. Formerly Examiner in Patent Office. FOURTEEN YEARS' PRACTICE.

THE MOORE & WHITE CO., Philadelphia, Pa.

Friction Clutch Pulleys, Cut-off Couplings, &c.



FOR SALE.

A valuable plant of machinery consisting of Milling Machines, Screw Machines, Engine Lathes, Drill Presses, Heavy Drops and Presses, &c., &c., also Tools, Belting and Factory Fixtures, formerly the property of the Howe Sewing Machine Co. Address

THE NEW HOWE MFG. CO., Bridgeport, Conn.

GLEASON MACHINE TOOLS

Engine Lathes, 22 inch to 72 inch swing.
Iron Planers, 26 inch to 84 inch wide.

HILL, CLARKE & CO., 156 OLIVER ST., BOSTON.

◎ FOR SALE. ◎

PULLEY PATTERNS

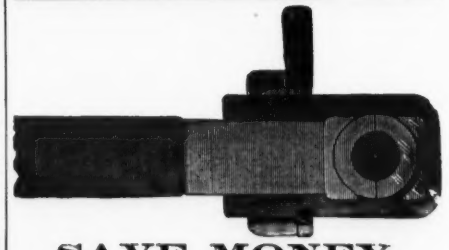
A set of Iron Pulley Patterns in halves with curved arms. Diameters from eight to twenty by inches, and to forty-eight inches diameter, varying by two inches. 163 in all. No hubs. These have been set aside for some time by our moulding machines, and are offered for sale, low.

Also one set of Hangers; three sets of Mortising Machine; one set of Moulding Machine; two sets of Spoke Lathe; and one set of Upright Shaper Patterns.

THE LANE & BODLEY CO. CINCINNATI, O.

HENRY CAREY BAIRD & CO., INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS, 810 Walnut St., Philadelphia.

☞ Our New and Revised Catalogue of Practical and Scientific Books, 80 pages, 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the World who will furnish his address.



SAVE MONEY,

BY BUYING YOUR

STRAP JOINTS

FROM COOKE & CO., 22 CORTLANDT STREET, NEW YORK

WRITE FOR PRICES,

Mentioning *American Machinist.*

NOTICE.

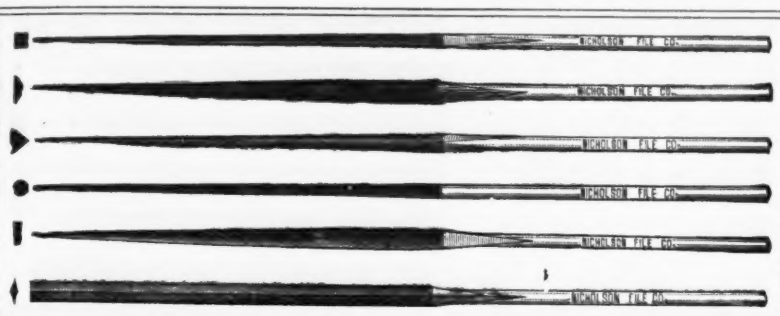
The unprecedented and well deserved success of the "Betts" Boring Mill has, naturally enough, aroused the jealousy of a Western competitor, and caused them to send broadcast through the land certain circular matter containing misrepresentations and threats about infringements of patents *LONG SINCE EXPIRED.*

We desire to inform those now using our Mills, those for whom we are now building Mills, and those contemplating the purchase of a Mill, in case they are alarmed by these useless and antiquated threats, that we stand ready and willing to guarantee our Mills entirely free from any infringements whatsoever.

And further, we beg to state that, in the opinion of the most critical and discriminating mechanics, our Mills stand to-day, unequaled by any for strength and durability, and for convenient, rapid and economical handling.

BETTS MACHINE CO., MACHINE TOOL BUILDERS, WILMINGTON, DEL.

FILES and RASPS.



PROVIDENCE, R. I., U. S. A.

CRUCIBLE AND OPEN HEARTH
CAMERON SELF-HARDENING
STEEL
ESTABLISHED 1859.
HOWE, BROWN & CO., L't'd, Mfrs., Pittsburgh, Pa.
BRANCH OFFICES: 12 Cliff St., New York. 127 Oliver St., Boston. 228 Lake St., Chicago.

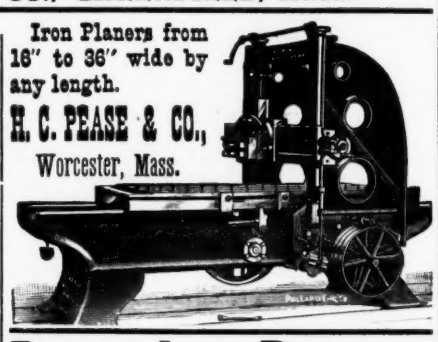
Established in 1874.
CLEVELAND TWIST DRILL CO.
Corner Lake & Kirtland Sts., Cleveland, O.
101 Chambers Street, New York.
85 Queen Victoria St., London, Eng.

FINE TAPS, DIES, REAMERS, ETC.

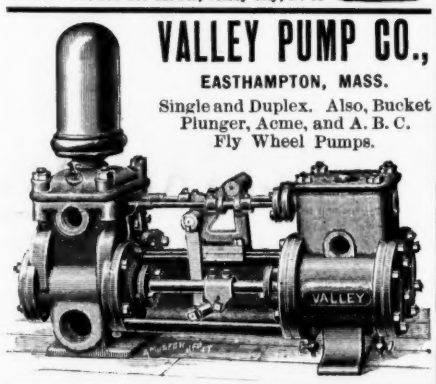
LIGHTNING AND GREEN RIVER SCREW PLATES.
Bolt Cutters, Hand and Power Drilling Machines, Punching Presses, Tire Benders, Tire Upsetters and Other Labor-Saving Tools. Send for Price List.
WILEY & RUSSELL MFG. CO., GREENFIELD, MASS.

Maslin's Patent Pulsator Pump.
PAT. FEB. 12, 1889.
Cheapest and Best Automatic Steam Vacuum Pump. Handling DIRTY and GRITTY LIQUIDS without Wear, Oil or Care. Simple, Economical, Efficient & Durable. Pumping Plants for Contractors, Irrigation, Water Works, Railroads, Mining & General Hydraulic Purposes. Write or call for Circulars. JOHN MASLIN & SON, SOLE MANUF'RS, 165-167 1st St., Jersey City, N. J.

Iron Planers from 16" to 36" wide by any length.
H. C. PEASE & CO.,
Worcester, Mass.



VALLEY PUMP CO.,
EASTHAMPTON, MASS.
Single and Duplex. Also, Bucket Plunger, Acme, and A. B. C. Fly Wheel Pumps.



Pease Iron Planers.
All Sizes 16 in. to 36 in. wide carried in stock.
HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON, MASS.

SHARTLE'S
BULL DOG.

THE HARDER YOU PULL, THE TIGHTER IT HOLDS.
CLASS "G"
This style is made for general machine shop use from 1 3-4 in. to 8 in. or larger. Can't slip. No wrench required, and satisfaction guaranteed. Write for catalogue showing the different styles. MANUFACTURED BY
THE MIDDLETOWN (OHIO) MACHINE CO.

Root's Force Blast Rotary Blower.
FOR
FOUNDRIES, SMITH SHOPS, PNEUMATIC TUBES, VENTILATION, ETC.

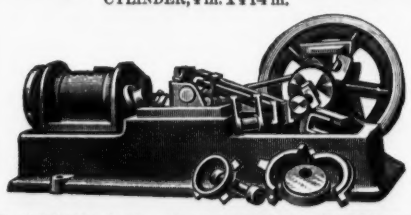
SLOW SPEED, POSITIVE BLAST, PERFECTLY BALANCED.
Best Mechanical Construction.
P. H. & F. M. ROOTS, Manufacturers,
CONNERSVILLE, IND.
S. S. TOWNSEND, Gen. Agt. } 22 Cortlandt St.,
COOKE & CO., Selling Agts. } NEW YORK.
In Writing, Please Mention This Paper.

MACHINISTS' FINE TOOLS.
STANDARD TOOL CO., ATHOL, MASS.
Catalogue and Price List free

I. PRICHARDS PROVIDENCE R.I. No 2 1-16 NEW STANDARD PUNCHES.
BEST SYSTEM on Earth for PUNCHING IRON AND STEEL.

VAN DUZEN'S
STEAM JET PUMP
For MILLS, FACTORIES, SHOPS, ETC.
For Elevating and Conveying Liquids.
For Emptying Pits, Sinks, Cesspools, etc., and as a Fire Pump.
10 Sizes, $7 to $75. Every Pump warranted.
Write for Descriptive Pump Circular, A
VAN DUZEN & TIFT, CINCINNATI, O.

Castings for High Speed Steam Engine.
CYLINDER, 4 in. x 4 1-4 in.



T. SHRIVER & CO., IRON AND BRASS FOUNDERS,
333 E. 56th St., N. Y. City.
Sets of Castings for Engine illustrated above, with *Cast-steel Shaft, Connecting Rod* and *Rock Shaft*, and *Brass Bearings*, boxed and delivered on boat or cars, in this city, on receipt of $38.00. This includes a *blue print* of working drawing

BEAUDRY'S DUPLEX FORGING PRESS, PUNCH AND SHEARS.
BEAUDRY & CO.
(Formerly of Beaudry's Upright Power Hammer,)
Sole Manufacturers.
Also Manufacturers of Hard Coal Heating Forges.
Room 4, Mason B'dg.
70 Kilby St., Boston, Mass.

REDUCED PRICES OF LECOUNT'S STRAIGHT TAIL DOG.

To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE.
1	3/4	$0.60	10	2 1/4	$1.35
2	7/8	.70	11	2 3/8	1.45
3	1	.70	12	3	1.60
4	1 1/8	.80	13	3 1/8	1.80
5	1 1/4	.80	14	4	2.10
6	1 3/8	.95	15	4 1/8	2.75
7	1 1/2	.95	16	5	3.25
8	1 3/4	1.10	17	5 1/8	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

C. W. LeCOUNT, South Norwalk, Conn.

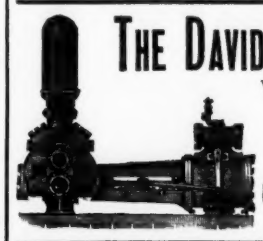
HALL DUPLEX STEAM PUMPS.
Send for 1890 Catalogue.

Fire Pump.

HALL STEAM PUMP CO.,
91 LIBERTY ST., NEW YORK.
PITTSBURGH. CHICAGO. ST. LOUIS.

Boiler and Pump Combined.

THE DAVIDSON STEAM PUMPS AND PUMPING ENGINES.

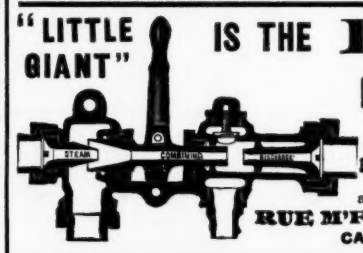


WARRANTED THE BEST MADE FOR ALL SITUATIONS.
Manufactured by
M. T. DAVIDSON.
PRINCIPAL OFFICE AND WORKS, 43-53 Keap St., Brooklyn, N. Y.
BRANCH OFFICES: 77 LIBERTY STREET, NEW YORK. 51 OLIVER STREET, BOSTON.

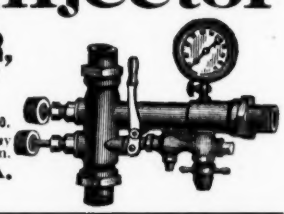
THE CHESTER FOUNDRY & MACHINE CO.,
CHESTER, PA.
Builders of CRANES of every type and capacity, MARINE, PUMPING and BLOWING ENGINES, CORLISS ENGINES, HYDRAULIC PRESSES, ACCUMULATORS, and SPECIAL MACHINERY of every description. CASTINGS IN DRY OR GREEN SAND AND LOAM.

DUPLEX STEAM PUMPS.
POWER PUMPS.
PRESSURE PUMPS.
INDEPENDENT CONDENSING APPARATUS
BARR PUMPING ENGINE CO.
GERMANTOWN JUNCTION, PHILADELPHIA, PENNA.

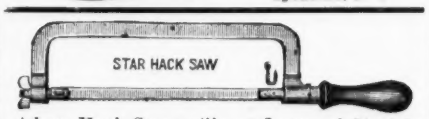
"LITTLE GIANT" IS THE Best Injector



For Feeding all Steam Boilers.
RUE'S • EJECTOR,
Superior to all others for Raising and Forcing Water and other Liquids.
Boiler Washer and Testing Device.
Uses Warm Water, avoiding injury and facilitating the Raising of Steam.
RUE M'F'G CO., PHILA., PA.
CATALOGUES FREE.



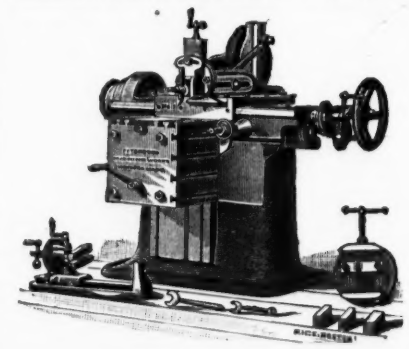
SWEET'S
Measuring Machine,
The only micrometer that will not lose its accuracy by wear.
Satisfaction Guaranteed.
SYRACUSE TWIST DRILL CO.
Syracuse, N Y



These Hack Saws will cut Iron and Steel beyond all expectation.
Iron working mechanics everywhere must and will use them. They do the work of files at one-tenth the cost, and in one-tenth the time. One Patent Nickel-plated Steel frame, and one dozen 8 inch Blades, sent by mail, prepaid, on receipt of $1.50. Hardware dealers will furnish them at at the same price. All saws marked with a star, and bearing our name are fully warranted.
MILLERS FALLS CO.,
93 Reade Street, New York

MACHINE TOOLS
ENGINE LATHES,
BRASS LATHES,
BORING AND TURNING MILLS,
SCREW MACHINES,
on hand and in process of construction.
BRIDGEPORT MACHINE TOOL WORKS,
E. P. BULLARD, PROPRIETOR. BRIDGEPORT, CONN.

FITCHBURG MACHINE WORKS
Manufacturers of METAL-WORKING MACHINES.



OFFICE AND WORKS,
13 to 21 MAIN STREET, Fitchburg, Mass.
Send for Catalogue (E.)

WILLIAM JESSOP & SONS, L'D.
MANUFACTORY, SHEFFIELD, ENGLAND. | Chief American Office, 91 JOHN ST., NEW YORK.
JESSOP'S BEST TOOL STEEL
Gold Medal, Paris, 1889.
Importation Orders Promptly filled.
ALL KINDS OF Steel in Stock.

WORTHINGTON
Independent Condenser
An Economical Addition to Steam Engines.
POWER GAINED or FUEL SAVED
AND
BOILER PRESSURE LOWERED
ESPECIALLY RECOMMENDED FOR
ELECTRIC LIGHT MILL BOAT and PUMPING ENGINES
HENRY R WORTHINGTON
NEW YORK
BOSTON PHILADELPHIA CHICAGO
ST LOUIS ST PAUL SAN FRANCISCO

SUGGESTIVE FACTS FOR STEAM USERS.

BEMENT, MILES & CO., PHILADELPHIA.

After the fullest investigation, have just ordered a battery of 402 H. P. of Harrison Safety Boilers for the large addition now being built to their extensive works.

Pamphlet describing and illustrating the type of boiler they selected mailed upon application to

HARRISON SAFETY BOILER WORKS,
Germantown Junction, Philadelphia, Pa.

NEW YORK, N. Y. 41 Dey Street. | CHICAGO, ILL. 6 So. Canal Street. | ATLANTA, GA. 9 No. Pryor Street. | MINNEAPOLIS, MINN. 707 Lumber Exchange.

POND ENGINEERING CO.,

CONTRACTING ENGINEERS,

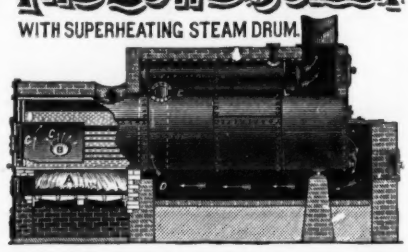
Engines, Boilers, Pumping Engines, Feed Pumps, Feed-water Heaters and Purifiers, Injectors, &c.

Send for ILLUSTRATED CIRCULAR.

St. Louis. Chicago. Kansas City. Omaha.

THE LOWE BOILER.

WITH SUPERHEATING STEAM DRUM.



Over fifty years' competition has proved this system of boiler to be the best in every respect. The **LOWE BOILER**, with all improvements, is the simplest, best wearing and most economical of any kind of fuel.

Send for description and histories of Steam Boilers and Feed Water Heaters (free) to

BRIDGEPORT BOILER WORKS
BRIDGEPORT, CONN.

THOS. H. DALLETT & CO.

1305 Buttonwood Street,
PHILADELPHIA, PA.

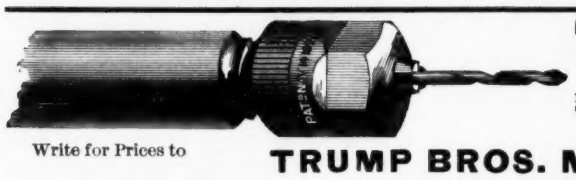
Portable Drills,
Hand Drills,
Boiler Shell Drills,
Light Drill Presses,
Special Machinery.

SEND FOR CATALOGUE.

THE STERLING WATER TUBE BOILERS

Have unusually large steam and water spaces and well-defined circulation. The fire-brick furnace and almost vertical water tubes give remarkable economy of fuel with rapid and steady steaming. Dry steam at any pressure. Large mud-drum. First cost moderate. Freedom from leakage and repairs. No cast metal. No hand-holes. Three man-holes give quick access to every part of the boiler.

THE INTERNATIONAL BOILER CO., Ltd.,
74 CORTLANDT STREET, NEW YORK.



TRUMP CHUCK.

The Best and Cheapest Chuck made. Will hold **STRAIGHT** or **TAPER** Shank Drills **ACCURATELY.**
3 sizes: ⅛", ¼" and ⅜".

Write for Prices to

TRUMP BROS. MACHINE CO.,
WILMINGTON, DELAWARE.

KEUFFEL & ESSER CO.
NEW YORK.
FACTORY, HOBOKEN, N. J.
Manufacturers of
Drawing Materials, Etc.,
Superior Swiss Drawing Instruments. Extra and Best Quality, German Drawing Instruments, Paragon, Duplex, Universal, Anvil Drawing, Helios, Blue Process Papers, Scales, Triangles, T-Squares, Drawing Boards, Standard Profile and Cross section Papers.

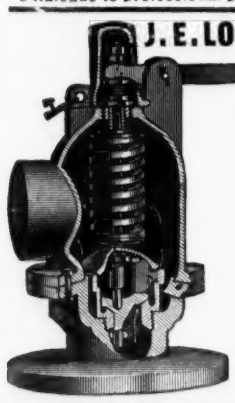
Catalogue to professional people on application.

TO BUYERS AND USERS OF MACHINERY.

You will save money and get what you pay for by having us examine machinery and report on the same before buying. Try us and be convinced.

We also make drawings and blue prints, and give **SPECIAL ATTENTION TO THE DESIGNING OF MACHINERY FOR ALL PURPOSES.** Send for Blue Book giving more information.

JONES & MACK,
MECHANICAL ENGINEERS,
119 W. 5th Street, Cincinnati, O.



J. E. LONERGAN & CO.

211 Race St., Phila.
Manufacturers of

PATENT OILERS,

Cylinder Sight Feed Cups, Government Regulation

POP

SAFETY VALVES

for Locomotive, Stationary and Marine Boilers, also the "Reliable" Steam Trap.

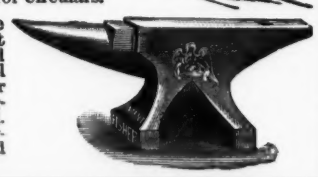
1888 Catalogue free on application.

EAGLE ANVIL WORKS,

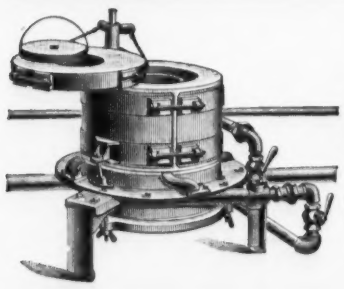
Trenton, N. J.

The Fisher Double Screw Leg Vise.—Warranted stronger grip than any other Vise. Always parallel and cannot be broken.

Send for Circulars.



The Eagle Anvil.—Best Cast Steel Face & Steel Horn. Better than any English anvil. Fully warranted and lower price.



AMERICAN GAS FURNACE CO.,

DESIGNERS AND MANUFACTURERS

GAS BLAST FURNACES.

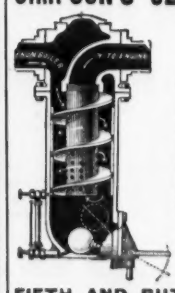
Send for Catalogue. Estimates made for any mechanical operation requiring **high, even** and **controllable temperature.**

No. 80 NASSAU ST.,
NEW YORK.

DIXON'S INDIA SILVER LEAD

FOR SMOOTH CASTINGS
COAT THE SURFACE OF MOULDS AND GATES.
JOSEPH DIXON CRUCIBLE CO.,
Manufacturers Pencils & Graphite Specialties,
JERSEY CITY, N. J.

SIMPSON'S CENTRIFUGAL SEPARATOR AND TRAP.



For supplying Clean and Dry Steam to Engines, Dryers, Etc. Also *Keystone Feed-Water Heaters and Purifiers, Keystone Belt Pumps, Simpson's Centrifugal Exhaust Heads*, and other Engineering Specialties. Steam Plants furnished complete and erected. Send for particulars.

KEYSTONE ENGINE AND MACHINE WORKS,
FIFTH AND BUTTONWOOD STS., PHILA.
Or, A. T. ARTHUR, Selling Agent, 18 Cortlandt St., N. Y.

WESTCOTT CHUCK CO., Formerly Oneida Steam Engine & Foundry Co., ONEIDA, N. Y.

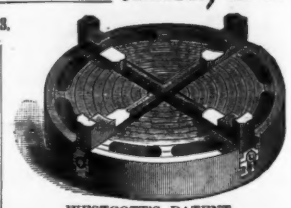
Manufacturers of all kinds of

LATHE AND DRILL CHUCKS

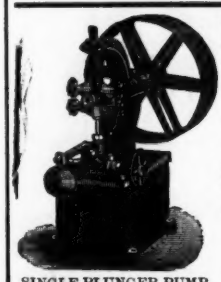
SEND FOR Catalogue.

SCROLL COMBINATION LATHE CHUCKS.

Diameter over all.	Will hold inside of Jaws.
4 9-16 in.	5 1-2 in.
6 in.	6 1-2 in.
7 1-2 in.	8 in.
10 1-8 in.	12 in.
13 1-4 in.	15 in.
16 in.	18 in.
18 1-2 in.	21 1-2 in.
21 1-4 in.	26 in.
24 in.	30 in.
30 in.	36 in.
36 in.	43 in.



WESTCOTT'S PATENT.



SINGLE PLUNGER PUMP.

Hydrostatic Machinery

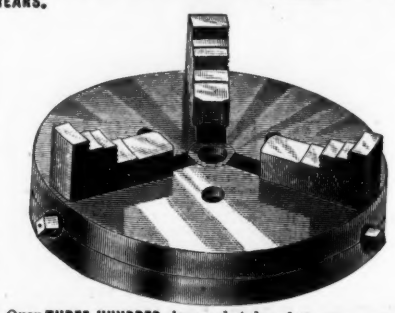
PRESSES,
PUMPS,
PUNCHES,
ACCUMULATORS,
JACKS,
VALVES,
FITTINGS,
&c., &c.

WATSON & STILLMAN,
204-210 E. 43d St., New York.

VOLNEY W. MASON & CO.,
Friction Pulleys, Clutches and Elevators,
PROVIDENCE, R. I.

"THE HORTON LATHE CHUCK"

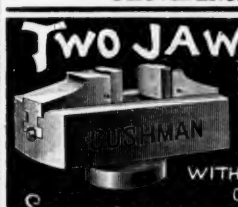
has sustained the tests and been the STANDARD for FORTY YEARS.



Over **THREE HUNDRED** sizes and styles of Chucks, made and kept in stock, by

THE E. HORTON & SON CO.,
WINDSOR LOCKS, CONN., U. S. A.
SEND FOR ILLUSTRATED PRICE LIST.

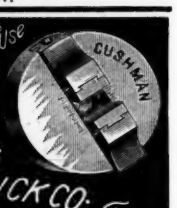
TWO JAW CHUCKS



BOX BODY
7-9 12 & 15 INCH
ROUND BODY
4½ 6 7 & 9 INCH
WITH VARIOUS STYLES OF JAWS.

For Brass Workers and for General Machinists Use

SEE NEW DESCRIPTIVE CATALOGUE



MANUFACTURED BY THE CUSHMAN CHUCK CO. HARTFORD, CONN.

SOLD BY ALL DEALERS.

"SWEETLAND" CHUCKS

SEND FOR DISCOUNTS.

THE HOGGSON & PETTIS MFG. CO.,
Est. 1849. NEW HAVEN, CONN.

INDEPENDENT CHUCKS.

(See AM. MACHINIST, Nov. 5, 1887.)

Before buying Chucks of this class, write us for particulars of our latest improvements. Different from other makes, and we claim several points of superiority which we submit to the judgment of mechanics.

THE D. E. WHITON MACHINE CO.,
NEW LONDON, CONN.
S. A. SMITH, 23 S. Canal St., Chicago, Western Agt.

LANSDELL SYPHON

A Cheap & Simple Steam Pump.

Working by direct action of steam. Has no valves or other working parts, and cannot get out of repair, cannot freeze, and will pump ashes, waste, or anything that can enter the pipes. Invaluable as a bilge pump.

MADE IN LEAD OR BRASS FOR ACIDS.

J. S. LENG'S SON & CO.,
4 Fletcher Street, NEW YORK.

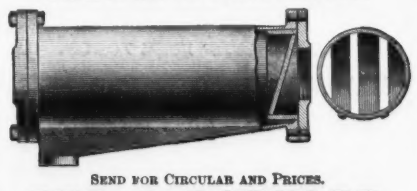
BARNARD'S SEPARATOR

For Separating and Removing Entrained Water from Live Steam;

AND

Condense Water, Oil, Dirt, Etc., from Exhaust Steam.

SPECIAL DESIGNS FOR SURFACE CONDENSERS.



SEND FOR CIRCULAR AND PRICES.

GEO. A. BARNARD,
15 CORTLANDT ST., NEW YORK.

FRISBIE FRICTION PULLEYS AND CLUTCHES.

THE D. FRISBIE CO.,
114 LIBERTY STREET, - NEW YORK

ALUMINUM, $2 PER POUND.

THE PITTSBURGH REDUCTION COMPANY, 95 Fifth Avenue, Pittsburgh, Pa., U. S. A., offer commercially pure aluminum at the following rates at Pittsburgh, Pa.:

Lots of 1,000 lbs. and over.....$2.00 ℔
Lots of 500 lbs. and over..... 2.25 ℔
Lots of 100 lbs. and over..... 2.50 ℔

Metal guaranteed to be equal in quality to the best metal manufactured by any other process.

Prices on sheets, wire, tubes or castings given upon application.

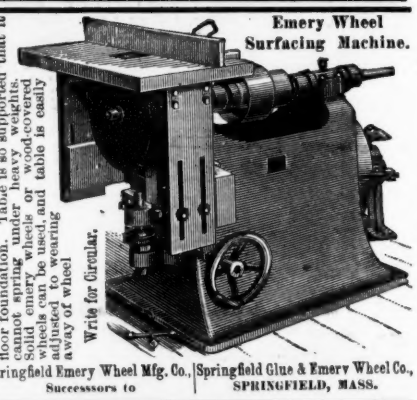
CROWELL'S POSITIVE PRESSURE BLOWER,

FOR

Blast and Smelting Furnaces, Forges, Cupolas or any Pneumatic Service where a positive pressure or Vacuum is desired. Any pressure from 1 to 10 lbs. can be obtained, and maintained. Slow running. Minimum of power required.

MANUFACTURED BY

HONESDALE IRON WORKS,
HONESDALE, PA.



Emery Wheel Surfacing Machine.

Base of machine has sufficient flare to give solid floor foundation. Table is so supported that it cannot spring under heavy weights. Solid emery wheels or wood-covered wheels can be used, and table is easily adjusted to wearing away of wheel

Write for Circular.

Springfield Emery Wheel Mfg. Co., Successors to Springfield Glue & Emery Wheel Co., SPRINGFIELD, MASS.

MACHINERY

For Reducing and Pointing Wire.

ESPECIALLY ADAPTED TO POINTING WIRE RODS AND WIRE FOR DRAWING.

For Machines or Information, address the Manufacturer,

S. W. GOODYEAR, Waterbury, Ct.

SPRUE CUTTERS. SHEARS. TOGGLE-JOINT DRAWING PRESSES.

STILL IN THE LEAD!

THE ONLY AMERICAN FIRM AWARDED

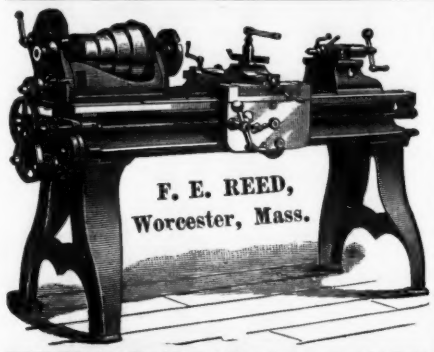
A GOLD MEDAL AT THE PARIS EXPOSITION 1889.

FOR SUPERIORITY IN PRESSES, DROP HAMMERS AND DIES.

THE STILES & PARKER PRESS CO.,
203-207 Centre Street, NEW YORK. MIDDLETOWN, CONN.

MORSE TWIST DRILL AND MACHINE COMPANY, New Bedford, Mass.
Manufacturers of **Morse Patent Straight-Lip Increase Twist Drills.**

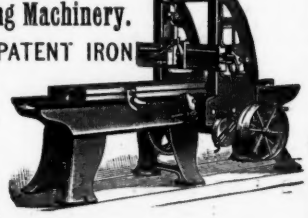
Solid and Shell Reamers, Beach's Patent Self-Centering Chuck, Bit Stock Drills.
DRILL GRINDING MACHINES, MILLING CUTTERS AND SPECIAL TOOLS TO ORDER.



ENGINE Lathes, Hand Lathes, Foot Lathes, Upright Drills and Milling Machines. Agents, MANNING, MAXWELL & MOORE, 111 LIBERTY STREET, NEW YORK.

FLATHER ENGINE LATHES
14, 15, 16, 18, 20, 24 and 28 INCH SWING.
ANY LENGTH OF BED UP TO 22 FEET.
HILL, CLARKE & CO.,
General Selling Agents,
156 OLIVER ST., BOSTON, MASS.

L. W. POND MACHINE CO.
Manufacturers of and Dealers in
Iron Working Machinery.
IMPROVED PATENT IRON PLANERS A SPECIALTY.
152 Union St., WORCESTER, MASS.



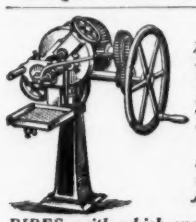
L. W. POND PLANERS.
FOR QUICK DELIVERY.
One Planer 38 in.x38 in.x10 ft.
One Planer 44 in.x40 in.x12 ft., with 2 heads.
HILL, CLARKE & CO.,
156 OLIVER ST., - BOSTON, MASS.

PECK'S PAT. DROP PRESS.
BEECHER & PECK, NEW HAVEN CONN.
DROP FORGINGS OF IRON OR STEEL
BEECHER & PECK, NEW HAVEN CONN.

SEND FOR CATALOGUE.
WORCESTER MACHINE SCREW CO.
WORCESTER, MASS.
Manufacturers of Set, Cap & Machine Screws, Studs, etc.

H. BICKFORD,
LAKE VILLAGE, N. H.
AND TURNING MILLS, 4, 5 and 6 Ft. SWING. BORING

"Eclipse" Hand Pipe-Cutting Machines.

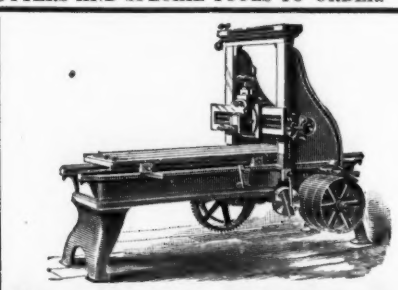


No. 1.—Powerful, inexpensive, simple in construction. Cuts and screws pipes ¼ to 2-inch. Easily carried about.

"ECLIPSE" Nos. 2 and 3. These are powerful and most efficient machines for cutting large PIPES, with which one man can easily cut off and thread 6-inch pipe.
No. 2 Cuts and Screws 2½ to 4 in.
No. 3 " " " 2½ to 6 in.
It will pay you to write us for particulars.

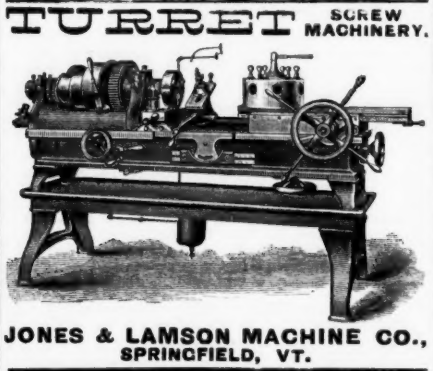
PANCOAST & MAULE, Philadelphia.
(Mention this paper.)
We also build Power Machines.

CARY & MOEN CO.
STEEL WIRE OF EVERY DESCRIPTION
& STEEL SPRINGS. NEW YORK 21 ST.

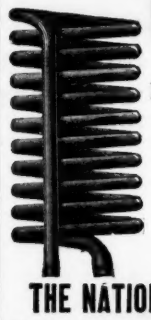


New Haven Manf'g Co.,
NEW HAVEN, CONN.
IRON-WORKING MACHINERY.

TURRET SCREW MACHINERY.

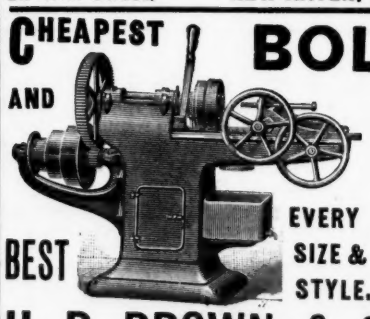


JONES & LAMSON MACHINE CO.,
SPRINGFIELD, VT.



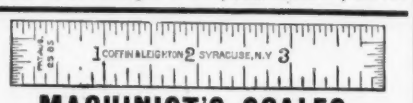
COILS & BENDS
—OF—
IRON,
BRASS and
COPPER
PIPE.
ALL STYLES.
THE NATIONAL PIPE BENDING CO.,
82 River Street, NEW HAVEN, CONN.

CHEAPEST AND BEST BOLT CUTTERS.



EVERY SIZE & STYLE.
H. B. BROWN & CO.,
EAST HAMPTON, CT.

OUR NEW **CATALOGUE OF TOOLS**
And Supplies sent free to any address on receipt of Ten Cents in Stamps (for postage).
Chas. A. Strelinger & Co., WOOD AVE. Detroit, Mich.



MACHINIST'S SCALES,
PATENT END GRADUATION.
We Invite Comparison for Accuracy with all others.
EVERY SCALE GUARANTEED. SEND FOR LIST.
COFFIN & LEIGHTON, SYRACUSE, N. Y.

W. C. YOUNG & CO., Worcester, Mass. Manufacturers of
Engine Lathes, Hand Lathes,
FOOT POWER LATHES, SLIDE RESTS, ETC.

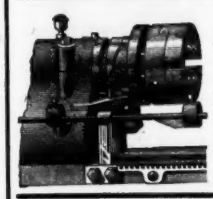
D. SAUNDERS' SONS, Yonkers, N. Y.
MANUFACTURERS OF
Steam & Gas Fitters' Hand Tools.
SEND FOR CIRCULAR.

Pipe Cutting
THREADING,
AND
Tapping Machines.

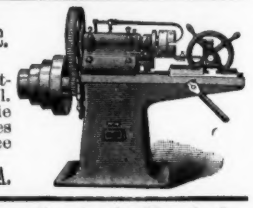
THE PATENT WHEEL PIPE CUTTER shown in the cut combines simplicity with strength and lightness. Easily adapted to various sizes of pipe. Rolling instead of sliding motion. No loose parts to become detached and mislaid. All wearing surfaces are of tool steel hardened. Less friction of parts than any other pipe-cutter made.

BUFFALO BLOWERS
FOR CUPOLAS, FORGES, FURNACES &C.
EXHAUSTERS, STEAM FANS
HEATERS & VENTILATING WHEELS.
BUFFALO FORGE CO.
BUFFALO, N.Y.

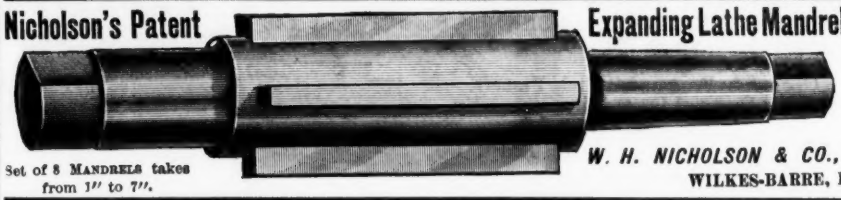
ADAMS
Automatic Bolt-Threading & Nut Tapping Machine.
Made in all Sizes to Cut from 1-4" to 6".



The simplest and most durable machine in existence. The threading head is made entirely of steel. No links, levers, springs, caps, cases, blocks or die rings in or about the head. Separate Heads and Dies Furnished. Write for descriptive circular and price list to
Capitol Mfg. Co., Rees St. near Halsted, Chicago, Ill., U. S. A.



Nicholson's Patent **Expanding Lathe Mandrels.**



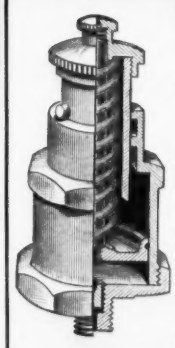
Set of 8 MANDRELS takes from 1" to 7".
W. H. NICHOLSON & CO.,
WILKES-BARRE, PA.

WILLIAM BARKER & CO.,
Manufacturers of
Iron and Brass Working
MACHINERY,
140 & 142 E. SIXTH ST.,
Near Culvert,
CINCINNATI, O.
Send for Circulars and Prices.

HUGO BILGRAM,
440 N. 12th St., Phila., Pa.
Maker of all kinds of
MACHINERY.
Special facilities for Accurate Work.

Bevel Gears cut theoretically Correct.

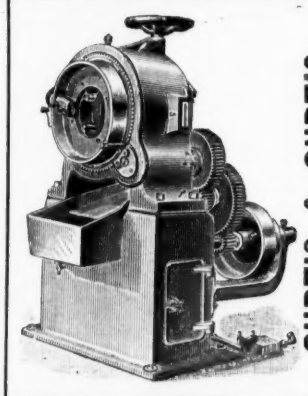
BLAISDELL ENGINE LATHES.
Great Variety of Styles and Sizes on Hand.
AND ALSO
NEW PATTERN UPRIGHT DRILLS.
HILL, CLARKE & CO.,
156 OLIVER ST., BOSTON, MASS.



LACKAWANNA GREASE CUP
Will Save its Cost in Oil alone Several Times per Annum.
SAVES ALSO IN LABOR, AND COST OF COTTON-WASTE. PREVENTS DRIPPING AND SPATTERING.
A POSITIVE FORCE FEED with the most PERFECT REGULATION and GREATEST CONVENIENCE in operation yet attained in any device for the lubrication of machinery. Works equally well in every possible position.
Lackawanna Lubricating Co.,
41 Coal Exchange, Scranton, Pa.

BARNES' PATENT UPRIGHT DRILLS.

20 to 42 inch swing, with both worm, and lever feed, self-feed and back-geared.
Barnes' Patent Friction Driver, Sensitive Drill. Single and Multiple Spindle.
Barnes' Patent Engine Lathe.
15 inch swing, 6 foot or 8 foot bed.
They have advantages not found in other machines in this line. It will pay parties desiring to purchase or know more about these machines to send for full description and prices to
W. F. & JOHN BARNES CO.,
ROCKFORD, ILL.
Address No. 1995 Ruby St.



CURTIS & CURTIS,
66 CARDEN ST., BRIDGEPORT, CONN.
Pipe Cutting and Threading Machinery,
FOR HAND OR POWER.
RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES.

BOYNTON & PLUMMER,
WORCESTER, MASS.
Manufacturers of
Shaping Machines,
Drilling Machines,
Bolt Cutting Machines.
Send for Catalogue.

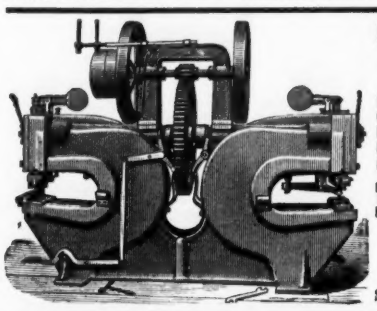
A NEW INVENTION.
SURE GRIP STEEL TACKLE BLOCK.
HALF THE COST of hoisting saved to Machinists, Contractors, Butchers, Builders and others. Admitted to be the greatest improvement EVER made in Tackle Blocks. The cheapest in the market. *Write for Catalogue.*
FULTON IRON & ENGINE WORKS,
29 BRUSH STREET,
Established 1852. DETROIT, MICH.

FRICTION CLUTCH PULLEYS AND CUT-OFF COUPLINGS
JAS. HUNTER & SON,
North Adams, Mass.

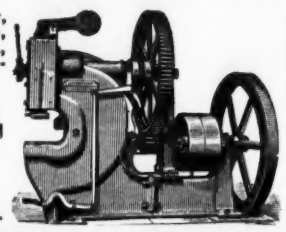
DAMPER REGULATORS.

Our Steam Damper Regulator is the most perfect and simplest machine in the market. Price, $60 and $100. Any one can apply it. Send for circular to Mason Regulator Co., Boston.

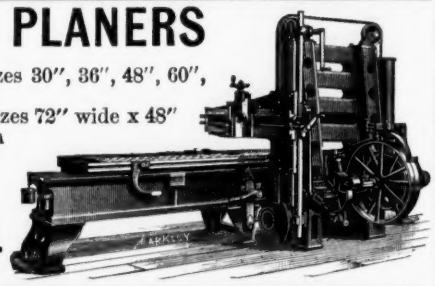
WILLIAM SELLERS & CO., Incorporated.
PHILADELPHIA, PA.
BUILDERS OF
MACHINE TOOLS FOR WORKING IRON AND STEEL,
Improved TURNTABLES for LOCOMOTIVES, CARS and PIVOT BRIDGES.
High Speed Power Traveling Cranes and Hand or Power Swing Cranes, Shafting, Pulleys, Hangers, &c., for transmission of power. Improved Self-Adjusting Injector of 1876. Self-Acting Injector of 1887. Fixed-Nozzle Automatic Injector of 1885.
INJECTORS for ALL CONDITIONS of LOCOMOTIVE and STATIONARY SERVICE



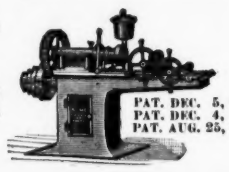
THE LONG & ALLSTATTER CO. Hamilton OHIO.
Double, Single, Angle-Bar, Gang, Horizontal, Twin, Boiler, Spacing, Gate, Multiple, Belt and Steam-Driven
Punches and Shears,
OVER 300 SIZES.
ALSO
Power Cushioned Hammer.
Send for New Catalogue.



THE OPEN-SIDE IRON PLANERS
STANDARD OPEN-SIDE PLANER, Sizes 30″, 36″, 48″, 60″, by any desired length.
OPEN-SIDE EXTENSION PLANERS, Sizes 72″ wide x 48″ high x 10′ long, up to 120″ wide x 72″ high x 20′ long.
Open-Side Frog and Switch Planers.
Extra Heavy and Powerfully Geared Up.
The DETRICK & HARVEY MACHINE CO.
BALTIMORE, MD.

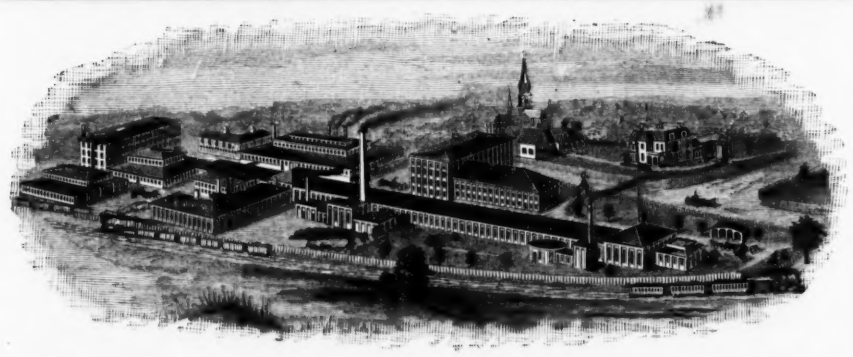


ACME MACHINERY CO.
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single & Double Automatic BOLTCUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.
FIRST PREMIUM, CINCINNATI CENTENNIAL.



8 DIFFERENT KINDS. TILE Machines BRICK MACHINES CAPACITY 10,000 to 100,000 PER DAY.
Full FACTORY OUTFITS

Write for Catalogue to **THE FREY, SHECKLER COMPANY, BUCYRUS, OHIO, U.S.A.**



The Corliss Steam Engine Co.
PROVIDENCE, R.I.
Incorporated June, 1856; Established by
GEORGE H. CORLISS,
INVENTOR OF THE CELEBRATED
"CORLISS ENGINE."
DESIGNER & BUILDER OF THE FAMOUS
"CENTENNIAL ENGINE."
Exhibited at the Philadelphia Exposition, 1876.

These works have been fully equipped, at great cost, with heavy special tools, of his invention, for the manufacture of this perfected engine, which is a guarantee of superiority in workmanship, and interchangeability of parts never before attempted in the line of steam machinery.

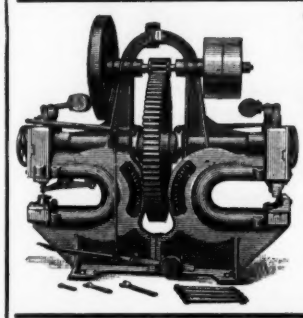
The public will understand that we have no relations with American or European builders of so-called "Improved Corliss Engines," and that the final and perfected Engine of Mr. George H. Corliss, embodying his latest ideas, is to be obtained exclusively at our works.

ALSO MANUFACTURERS OF THE

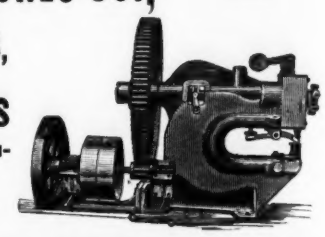
CORLISS PATENT VERTICAL TUBULAR WATER LEG BOILER,

Especially adapted for compound and triple expansion engines requiring superheated steam and at very high pressure.

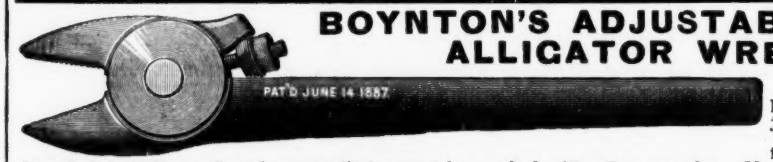
BEMENT, MILES & CO.,
PHILADELPHIA, PA.
—BUILDERS OF—
METAL-WORKING MACHINE TOOLS
FOR
Railroad Shops, Locomotive and Car Builders, Machine Shops, Rolling Mills, Steam Forges, Ship Yards, Boiler Shops, Bridge Works, Etc., Etc.



The HILLES & JONES CO., WILMINGTON, DEL.
MANUFACTURERS OF
PUNCHES AND SHEARS,
All Designs and Sizes,
AND A FULL LINE OF
MACHINE TOOLS
FOR
Boiler Makers, Bridge Builders, Ship Builders, Railroad Shops, Locomotive and Car Builders, etc., etc.



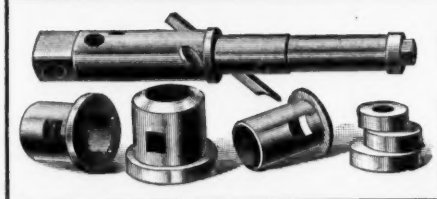
THE AERATED FUEL COMPANY,
425 MAIN STREET, SPRINGFIELD, MASS. J. H. BULLARD, MANAGER.
FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT, OR ASHES!
Represented by WILLIAM PICKETT, SON & CO., 170 Lake St., Chicago; W. S. COLLINS, 171 Broadway, New York. CHILION JONES, Gananoque, Can. G. M. SMITH, Los Angeles, Cal. KALAMAZOO SPRING AND AXLE CO., Kalamazoo, Mich. C. S. BARROWS, 46 Wade Building, Cleveland, Ohio. GILBERT & BARKER MFG. CO., General Agents for the United States, Springfield, New York and Boston.
Sept. 29, 1885. July 5, 1887. Feb. 5, 1889. July 23, 1889.
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



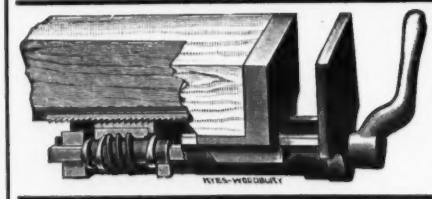
BOYNTON'S ADJUSTABLE ALLIGATOR WRENCH.
Quick and handy in adjustment. Invaluable for work on clipped pipe, in close coils and corners that cannot be reached with other wrenches. Made entirely of drop forged steel. *Four sizes.*
CAMPBELL PRINTING PRESS AND MFG. CO., MFRS.
160 WILLIAM ST., NEW YORK. 325 DEARBORN ST., CHICAGO.

STEEL CASTINGS
FROM 1-4 TO 15,000 LBS. WEIGHT.
True to pattern, sound, solid, free from blow-holes and of unequaled strength.
Stronger and more durable than iron forgings in any position or for any service whatever.
60,000 CRANK SHAFTS and 50,000 GEAR WHEELS of this steel now running prove this.
Crossheads, Rockers, Piston Heads, etc., for Locomotives.
STEEL CASTINGS of every description.
Send for Circulars and prices to
CHESTER STEEL CASTINGS CO.,
Works, Chester, Pa. Office 407 Library St., Philadelphia, Pa.

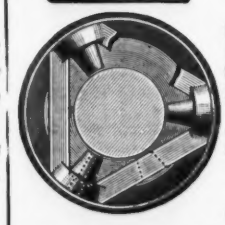
Our Location, Foundry Capacity and Machine and Pattern Shop Equipment afford us **special facilities for furnishing HEAVY CASTINGS TO ORDER,** in any quantity up to size 20,000 lbs., or **SMALL CASTINGS** where large quantities are required. Get our estimates and prices before ordering.
ALLENTOWN FOUNDRY & MACHINE CO.,
3d and Walnut Streets, ALLENTOWN, PA.



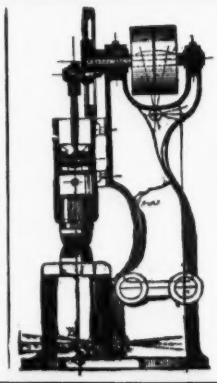
—THE—
Vance Lightning Flue Cutter
For removing Flues from Locomotive and Stationary Boilers. One man can cut five hundred (one end) in a day. In use in the leading Railroad Shops of the country. Combination Cutter for removing 2 in., 2 1-4 in., 2 1-2 in. and 3 in. Flues, $50. Sent on approval to Railroad Co's. Liberal Discounts to the Trade.
VANCE TUBE CUTTER CO., Geneva, N. Y.



QUICK-ACTION VISES,
For Pattern Makers and Wood Workers.
WYMAN & GORDON,
WORCESTER, MASS.
DROP FORGINGS.



THE
BROWNELL ANTI-FRICTION Step or Thrust Bearing
FOR
Lathes, Drills, Worm Shafts of Elevators or Hoists, Jack Screws, Mill Stones, Water Wheel and Propeller Shafts.
Bearings of all sizes made to order, and patent rights for sale by
G. L. BROWNELL,
WORCESTER, MASS.
Correspondence Solicited.



THE AMERICAN PATENT OF THE
Pneumatic Hammer,
described in the reading columns of number 7, Feby. 13, 1890, of the American Machinist, is to be sold. Full particulars are given on application by
L. W. BREUER, SCHUMACHER & CO.,
KALK, near COLOGNE, GERMANY.

BALL AUTOMATIC CUT-OFF ENGINES,
ERIE, PA.
The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.
CHARLES R. VINCENT & CO.,
NEW YORK SELLING OFFICE, 15 CORTLANDT STREET.

NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES.

In Use, Over 2,500.

25 to 1,000 H. P.

These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

SALES AGENTS: **W. L. SIMPSON,** 10 TELEPHONE BUILDING, 18 CORTLANDT STREET, N. Y. N. W. ROBINSON, 154 Washington St., Chicago, Ills. ROBINSON & CARY, St. Paul, Minn.

KENSINGTON ENGINE WORKS, LIMITED, PHILADELPHIA.

Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

THE ALBANY STEAM TRAP CO.'S

BUCKET AND GRAVITATING

TRAPS.

Bucket.

Automatically drain the water of condensation from **HEATING COILS** and return it to the boilers whether the coils are **above** or **below** the water level in boiler, doing away with pumps and other mechanical devices for such purposes.

We also manufacture **Blessing's Patent Renewable Seat Stop and Check Valves.**—Send for Circular.

Albany Steam Trap Co., Albany, N. Y.

Gravitating.

"OTTO" GAS ENGINE WORKS.

SCHLEICHER, SCHUMM & CO.,

33d & Walnut Streets, Philadelphia. 151 Monroe Street, Chicago.

New York Agency, 18 Vesey St.

OVER 25,000 ENGINES SOLD.

HORIZONTAL "Otto" Gas Engines.

VERTICAL "Otto" Gas Engines.

TWIN CYLINDER "Otto" Gas Engines.

COMBINED "OTTO" GAS ENGINES AND PUMPS.

COMBINED "OTTO" GAS ENGINES AND DYNAMOS.

Consume 25 to 75 Per Cent. Less Gas than ANY other Gas Engine doing the same work.

Corliss Engines

Of the highest type, in all sizes, are made by

The Lane & Bodley Co.

CINCINNATI, O.

The merits of their engines are described in an illustrated pamphlet, which will be sent to any one interested.

PATENT UNIVERSAL SCREW-CUTTING CENTER DEPTH ANGLE AND **TWIST DRILL GAUGE.**

J. WYKE & CO., Fine Machinists' Tools.—**Boston, Mass.**—Send for Circular.

T. R. ALMOND, 85 Washington St., Brooklyn, N. Y., is prepared to *grant licenses* on moderate terms for the use of his

Patent Loose Pulley Lubricating Device,

illustrated in this paper, Jan. 23, 1890 issue. One tablespoonful of oil will last for months.

MACHINERY ON HAND.

9-in. Crank Shaper, H. & P. Good order.
12, 15, 22 and 15-in. Crank Shaper, Juengst. New.
24 in. Bridgeport Shaper, 2d hand. A 1.
24-in. Shaper, Bridgeport. New.
12-in. stroke Trav. Head Shaper. New.
22 in. x 5 ft. Planer, Wheeler. New.
24 in. x 6 ft. " Powell. New.
26 in. x 8 ft. " Pond. Good.
7 and 11 in. swing Hand Lathes. New
11 x 5 ft. and 14 x 6 ft. Engine Lathes, Prentiss.
16 x 8 ft. " " "
14, 16 and 18 in. " " Blaisdell.
14 and 16 in. x 6 and 7 ft. " " Bogert.
16 in. x 6 and 8 ft. Engine Lathe, McMahon. New.
18 in. x 8 and 10 ft. " " "
30 in. x 8, 10 and 12 ft. Engine Lathe, McMahon.
20 and 24 in. Engine Lathe, Bridgeport.
20 in. x 8 ft. " " W., L. & Co. Good.
20 in. x 14 ft. " " Wright. New.
28 in. x 14 ft. " " F. & S. New.
32 in. x 16 ft. " " F. & S. New.
16 in. x 10 ft. Islin Eng. Lathe. Good.
26 in. x 50 in. Pulley Lathe, Stevens. Good.
36 in. Stephens Pulley Lathe. New.
No. 1 and 2 Slate Sensitive Drill. New.
2, 3 and 4 Spindle Drills, Slate. New.
20, 22, 23, 25, 28 and 32 in. Drills. New.
Ames Index Milling Machine. Fair.
No. 3 National Bolt Cutter. New.
No. 2 Garvin Universal Miller. New.
1 No. 37 E. W. Bliss Co. Power Press. A 1 order.
I. X. L. Saunders Pipe Machine. A1 order.

Cold Rolled Shafting in stock, all sizes.

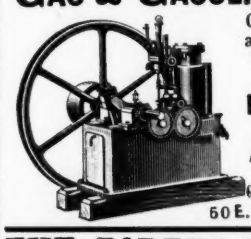
Full line of new Machinery. Write for what you want.

Send for our list of new and second hand tools for sale.

E. P. BULLARD,

72 Warren St., and 62 College Place, New York.

VAN DUZEN GAS & GASOLINE ENGINE



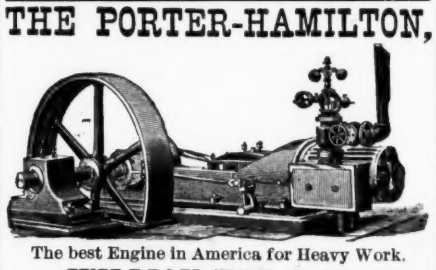
OPERATED with COAL and OTHER MANUFACTURED GASES AND GASOLINE.

RELIABLE AND ECONOMICAL.

Fully Warranted

VAN DUZEN Gas & Gasoline Engine Co. 50 E. 2d St., Cincinnati, O.

THE PORTER-HAMILTON,



The best Engine in America for Heavy Work.

WILLIAM TOD & CO.,

Youngstown, Ohio.

3/8" **FLEXIBLE METALLIC FILLET**

For Pattern Makers' Use.

H. WHITE, 44 N. 4th Street, Phila., Pa.

BRAINARD MILLING MACHINES,

25 Different Styles and Sizes.

HILL, CLARKE & CO.,

General Selling Agents,

156 OLIVER ST., BOSTON, MASS.

NEW AND IMPROVED MILLING MACHINE.

☞ Note the following new features:
☞ Overhanging arm removed without taking off the sleeve.
☞ Sleeve for the overhanging arm and the column cast in one piece.
☞ All movements operated from front of machine instead of under the table.
☞ Long bearings. Long and wide tables.
☞ Power feed entire length of table.
☞ Large spindles, hollow their entire length.
☞ Indexed feeds on all machines.
☞ Large cones, wide belts.
☞ Each machine furnished with a vise.
☞ Built either plain, back geared or universal.
☞ Write for prices, with cuts and full descriptions.

—THE—

LODGE & DAVIS MACHINE TOOL CO.,

CINCINNATI, OHIO.

EASTERN HOUSE:

64 CORTLANDT STREET,

NEW YORK.

WESTERN HOUSE:

68 & 70 SOUTH CANAL ST.,

CHICAGO

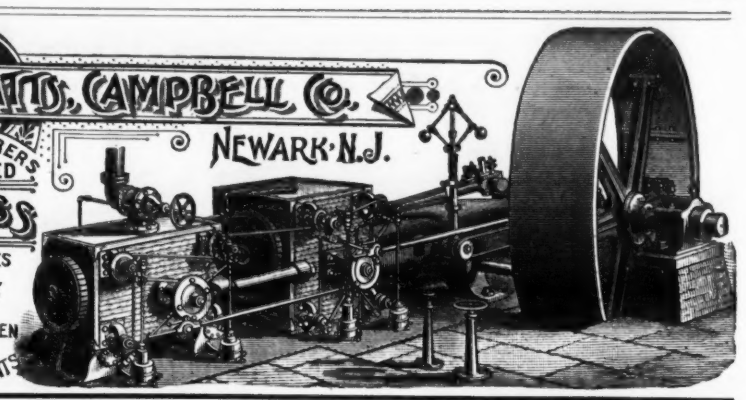
See advertisement, page 16.

THE WATTS, CAMPBELL CO.

MANUFACTURERS OF IMPROVED

CORLISS

NEWARK, N.J.



STEAM ENGINES IN FULL VARIETY.

CONTRACTS TAKEN FOR COMPLETE POWER PLANTS

Eclipse Corliss Engine.

FRICK COMPANY, Builders,

WAYNESBORO, PA.

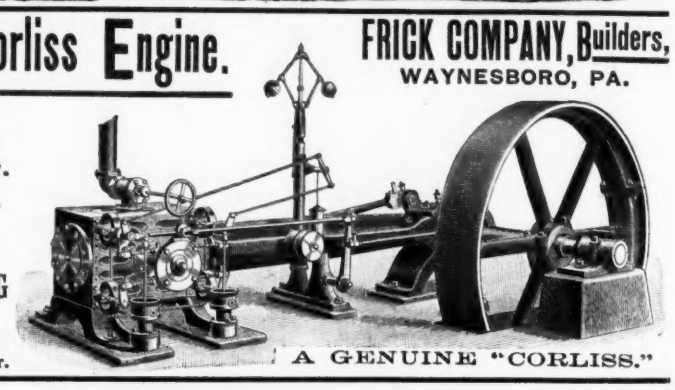
NON-CONDENSING, CONDENSING COMPOUND.

40 TO 1,000 H.P.

Send for Circulars.

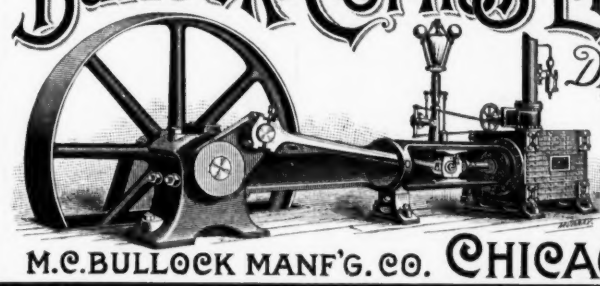
ICE-MAKING AND REFRIGERATING MACHINERY.

Send for Special Circular.



A GENUINE "CORLISS."

Bullock-Corliss Engines.



DIAMOND DRILLS FOR PROSPECTING.

BAND FRICTION HOISTS.

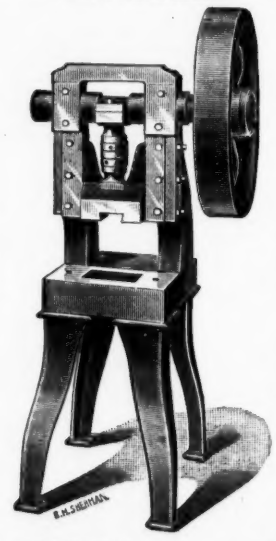
MINING MACHINERY.

M.C. BULLOCK MANF'G. CO. CHICAGO, U.S.A.

HERRICK & COWELL,

MANUFACTURERS

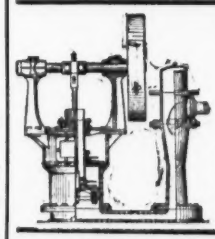
Drill Presses, Power and Foot Presses.



Emery Wheel Machinery, Paper Box and Special Machinery.

NEW HAVEN, - CONN.

SEND FOR CATALOGUE.



Belt Power Air Pump and Condenser.

CONOVER & CO.,

CONSULTING AND MECHANICAL ENGINEERS

95 LIBERTY ST., NEW YORK.

No Air Locks. 15 to 50 per cent fuel saved or equal amount of power gained. Runs with same economy as engine.

Adapted to all kinds of Engines. *Send for Circular.*

C. H. DE LAMATER & CO.

have closed their extensive manufactory at the **Foot of West 13th Street, New York,** and have sold the Hot Air Pumping Engine and Steam Pump business to the De Lamater Iron Works (incorporated in 1889), and the Propeller Wheel business to the Samuel L. Moore & Sons Co., of Elizabethport, New Jersey.

In order to close out the remainder of the stock, offer for sale

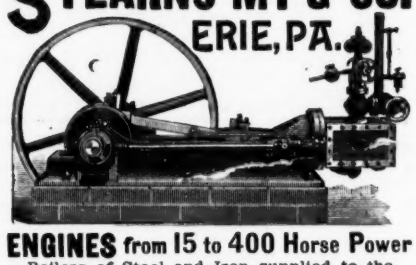
A Very Desirable Lot of Machinery,

such as lathes from 15" to 88" swing, planing machines 48"x45"x10', 53"x50"x12', 17"x14"x24', 72"x69"x24', and various other sizes; drilling machines, slotting machines, shaping machines, boring machines, bolt-cutting machines, cutting-off machines, nut tappers, milling machines, gear cutters, emery tool grinders, portable drills, screw-cutting machines, vises, lathe and planer tools, and a variety of small tools; also traveling and jib cranes.

Punching and shearing machines for boiler makers, with a general outfit of small tools. Blacksmiths' tools, such as anvils, sledges, tongs, etc. Pattern lathes, benches, saws, screws, nails, and a general supply of small tools. Foundry cranes, cupolas and small tools. Blocks, ropes, bolts, nuts, washers, packings, pipe and fittings, iron and brass valves. Boiler iron, steel plate and boiler rivets Bar iron and steel, also steam hammers, and two 8"x16" and one 10"x20" Rider cut-off engines.

STEARNS M'F'G CO.

ERIE, PA.

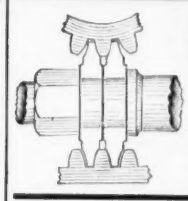


ENGINES from 15 to 400 Horse Power

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

SAW MILLS AND GENERAL MACHINERY

NEW YORK STORE, 46 Cortlandt St.



CLOUGH'S PATENT DUPLEX GEAR CUTTER

For cutting the teeth of gears; one Duplex Cutter cuts a pitch from 15 teeth to a rack inclusive.

Kept in stock from 4 to 36 pitch and warranted. Circular and price list free.

R. M. CLOUGH,

MERIDEN, CONN.

PLANER VISES.

THE GILKERSON MACHINE CO.,

HOMER, N. Y.

NEW AND SECOND-HAND

MACHINERY.

FOR IMMEDIATE DELIVERY.

Engine Lathes,	12 in. x 5 ft.	Young,	new
" "	14 in. x 6 ft.	Prentice,	"
" "	16 in. x 6 ft.	Old Style,	cheap
" "	16 in. x 6 ft.	Wright,	new
" "	16 in. x 6 ft.	Perkins,	"
" "	16 in. x 6 ft.	Fitchburg,	"
" "	16 in. x 6-8 ft.	Hendey,	"
" "	18 in. x 8 ft.	Blaisdell,	good order
" "	18 in. x 8 ft.	Prentice	new
" "	20 in. x 10 ft.	Wright,	"
" "	21 in. x 8-10 ft.	Fitchburg,	good order
" "	24 in. x 12 ft.	"	new
" "	24 in. x 12 ft.	Wright,	"
" "	27 in. x 12 ft.	Lathe & Morse,	"
" "	30 in. x 16-18 ft.	Wright	"
" "	78 in. x 12 ft.	Gap Bed,	good order
Pulley Lathe	36 in. 2 heads,	Niles,	"
" "	36 in. 1 head,	Stevens	"
Turret Chucking Lathes,	15 & 20 in.	Hendey,	new
Fox Lathe	15 in. x 5 ft. sq. Arbor Chasing Bar,		"
Planers,	24 in. x 24 in. x 6 ft.	Fitchburg,	"
"	24 in. x 24 in. x 6 ft.	Lathe & Morse,	"
"	24 in. x 24 in. x 7 ft.	Whitcomb	good order
"	30 in. x 26 in. x 7 ft.	Putnam,	"
"	42 in. x 42 in. x 12 ft.	Fitchburg,	"
"	60 in. x 60 in. x 24 ft.	Heavy pattern,	"
Drills,	20 in. wheel and lever feeds,	Prentice,	new
"	21 in. wheel and feed back gears,	"	"
"	25 in. back gears and automatic feed,	"	"
"	28 in. " " "	"	"
"	32 in. " " "	"	"
Shapers,	12 in. stroke, Crank,	Gould & Eber'dt,	good order.
"	14 in. "	Trav. head, Fitchburg,	new
"	24 in. "	Crank, Gould & Eber'dt,	"
"	26 in "	Rack, Lodge, Davis,	"
Screw Machines,	No. 1, Chasing bar & feed,	B. & S.	A1
"	" " 3, "	"	A1
"	" " 2 with feed,	Jones & Lamson,	A1

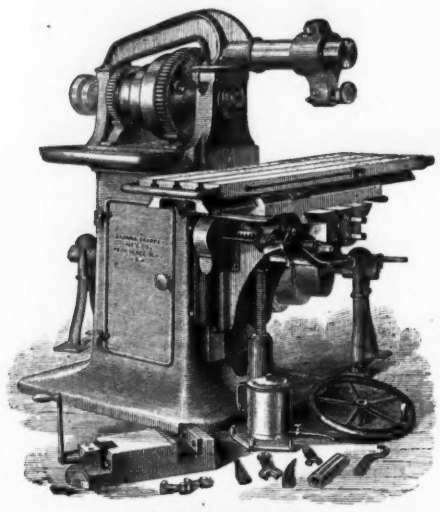
Bridge and Boiler Tools, new and second hand.

Agent for HALSEY PORTBALE DRILLS, and

Send for full list. FITCHBURG MACHINE WORKS.

J. J. McCABE,

68 CORTLANDT ST., NEW YORK.



No. 6 PLAIN M. M.

Brown & Sharpe Mfg. Co.,

PROVIDENCE, R. I., U. S. A.

Milling Machines.

Milling Cutters.

Special Formed Cutters.

CATALOGUE MAILED ON APPLICATION.

S. A. SMITH,

Western Representative,

23 So. Canal St., Chicago, Ill.

THE PRATT & WHITNEY CO.,

HARTFORD, CONN.,

Manufacture Gardner & Woodbridge patent and new Threading Tool, Rhodes' Square Thread Tool, Woodbridge Lathe and Planer Tool, Johnson's Cutting-off Tool, Kidd's Improved Dividers and Adjustable Caliper Gauges.

WESTERN BRANCH, 100 West Washington Street, Chicago, Ills.

THE BILLINGS & SPENCER CO.

HARTFORD, CONN. U.S.A.

MANUFACTURERS OF BILLINGS' DROP FORGED LATHE DOGS FORGED FROM BEST STEEL FOR THE PURPOSE

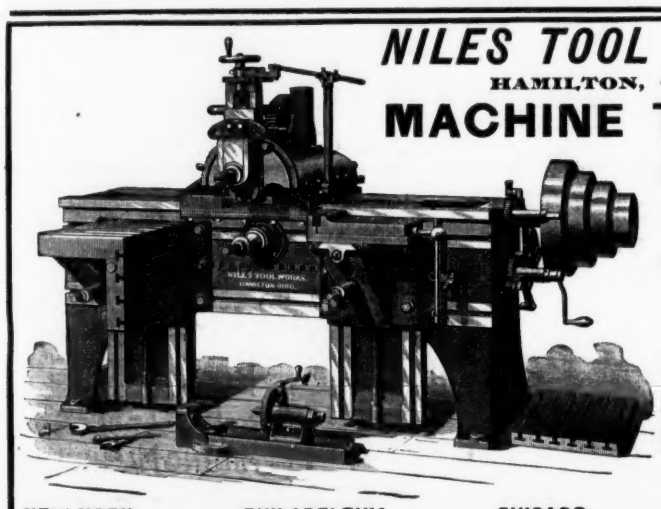
IN 12 SIZES 3/8 UP TO AND INCLUDING 4 IN ALSO CLAMP AND DIE DOGS

DROP FORGINGS OF COPPER, IRON AND STEEL OF ALL DESCRIPTIONS

NILES TOOL WORKS,

HAMILTON, OHIO.

MACHINE TOOLS.



SHAPING MACHINES.

TRAVELING HEAD.

16, 18 and 24 inch Stroke.

Extra heavy and powerful.

NEW YORK, 96 Liberty St. PHILADELPHIA, 705 Arch St. CHICAGO, Phenix Building. PITTSBURGH, Penn Building.

WARNER & SWASEY,

MACHINE TOOLS CLEVELAND, OHIO.

For IRON and BRASS WORK.

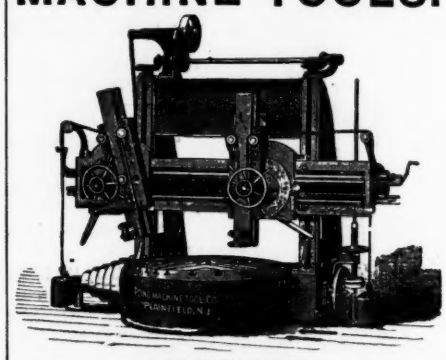
Illustrated Catalogue on application.

THE POND MACHINE TOOL CO.,

Formerly of Worcester, Mass.

MANUFACTURERS OF

MACHINE TOOLS.



BORING MILLS.

Radial Drills, Planers, Lathes, Heavy & Powerful, from new patterns of the latest and best designs.

SALESROOM & OFFICE, 113 Liberty St., N. Y. City.

NEW SHOPS, PLAINFIELD, N. J.

GRANES

THE YALE & TOWNE MFG CO.,

STAMFORD CONN

NEW YORK CHICAGO PHILA. BOSTON

JENKINS BROS.' VALVES.

Every valve tested and warranted, all parts interchangeable.
Nothing but best Steam Metal used in the manufacture.
The Keyed Stuffing Box and Disc Removing Lock Nut
Is used only in the Jenkins Bros.' Valves.
None are genuine unless stamped with "Trade Mark."
Should you order INSIST on having Jenkins Bros.' Valves.

71 JOHN STREET, NEW YORK. *54 DEARBORN STREET, CHICAGO.*
21 NORTH FIFTH STREET, PHILA. *105 MILK STREET, BOSTON.*

GEO. W. FIFIELD,

MANUFACTURER OF

ENGINE LATHES

FROM 16 to 48 IN. SWING.

Cuts, Photographs and Prices furnished on application.

Lowell, Mass., U. S. A.

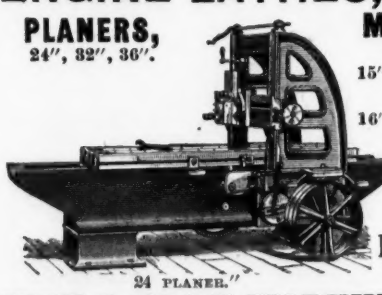
HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONN.

J. M. ALLEN, President.
Wm. B. Franklin, Vice-President.
F. B. ALLEN, Second Vice-President.
J. B. PIERCE, Secretary & Treasurer.

ENGINE LATHES, SHAPERS & DRILLS.

PLANERS, 24″, 32″, 36″.



24 PLANER.

MILLING MACHINES.

SHAPERS,
15″ and 20″ Crank, 20″, 26″, 32″ Geared.

ENGINE LATHES,
16″, 18″, 19″, 21″, 24″, 27″, 30″, 32″ & 38″.

20 in. Upright Drills. 25 in. Back Geared, 24 " " " and 28, 32 and 40 inch Power Feed Drills.

THE Lodge & Davis Machine Tool Co., Manufacturers of

IRON & BRASS WORKING MACHINERY.

WORKS, CINCINNATI, OHIO.

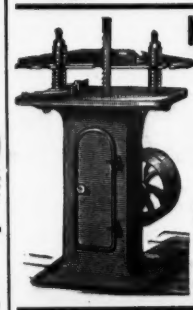
Write for prices; it will pay you. Special attention given to complete outfits.

NEW YORK, 64 Cortlandt St. CHICAGO, 68 & 70 S. Canal St.

See advertisement, page 15.

Every machine or manufacturing concern should send for the list of 600 sizes of cut iron spur and bevel gear wheels and racks lately issued by the Lexington Gear Works, of Lexington, Mass.

GEORGE B. GRANT, Proprietor.



Key-Seating Machines and 20 in. Drills

A SPECIALTY.

SEND FOR LIST OF

New and Second-Hand

Lathes, Planers, Drills, or anything in Machinists' Tools or Supplies.

W. P. DAVIS,

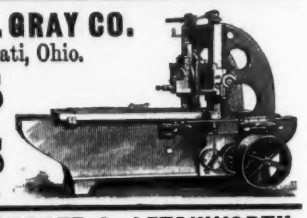
Rochester, N. Y.

Works at North Bloomfield.

THE G. A. GRAY CO.

Cincinnati, Ohio.

PLANERS AND LATHES A SPECIALTY.



GOULD & EBERHARDT,

NEWARK, N. J.

Eberhardt's Patent

AUTOMATIC GEAR CUTTER.

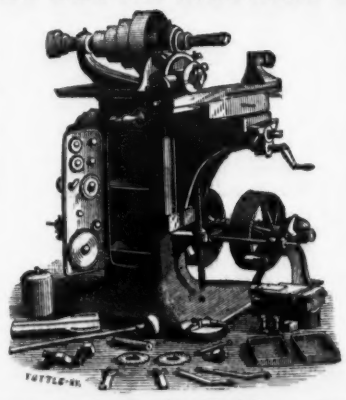
18 in. 25 in. 36 in. 50 in. 60 in. 84 in. Sizes.

"Experts pronounced it the best."

GEAR AND RACK CUTTING TO ORDER.

THE GARVIN MACHINE CO.,

Universal Milling Machine.



Manufacturers of Machinists' and Iron Workers' Tools, Lathes, Planers, Milling Machines and Drills. Special Tools for all kinds of manufacturing to order.

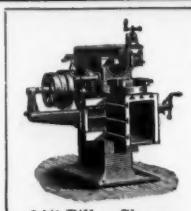
Gear and Rack Cutting, Milling and Index Drilling to Order.

LAIGHT & CANAL STS., NEW YORK.

STEEL CASTINGS.

PRATT & LETCHWORTH, PROPRIETORS

BUFFALO STEEL FOUNDRY, BUFFALO, N. Y.



24″ Pillar Shaper.

15″ Pillar Shaper.

25″ Pillar Shaper.

THE HENDEY MACHINE CO.

TORRINGTON, CONN.

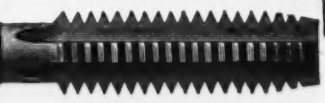
MANUFACTURERS OF

MACHINE TOOLS

SEND FOR OUR CATALOGUE.

J. M. CARPENTER

PAWTUCKET, R. I.



Manufacturer —of— TAPS & DIES